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UNIVERSITY OF MICHIGAN
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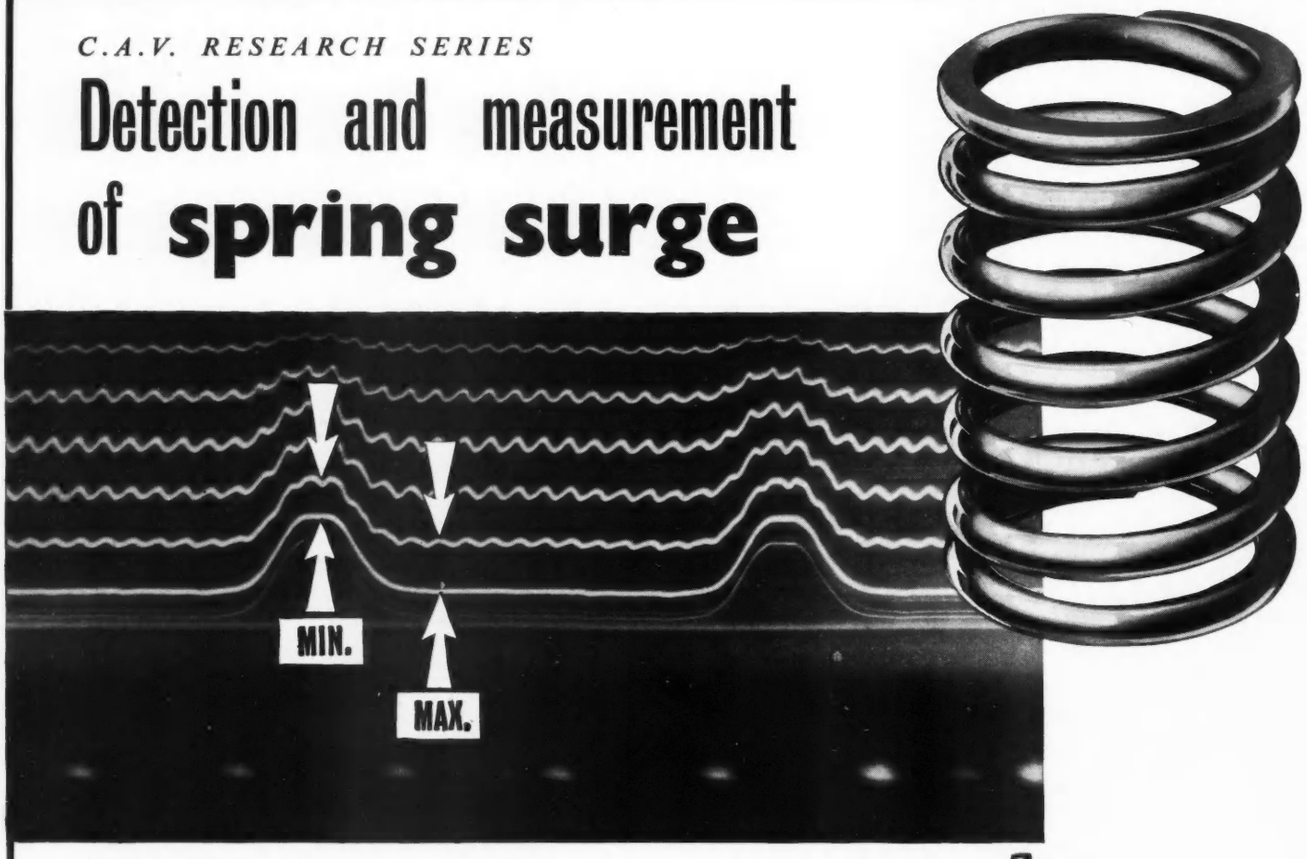
PRISM BLOCKS ON SURFACE GRINDER.

C.A.V. RESEARCH SERIES

Detection and measurement of **spring surge**

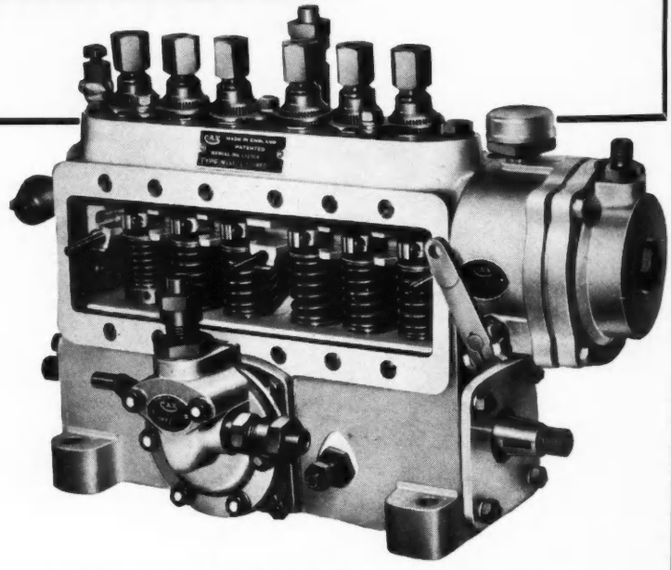


The firm line shows the cam rise over two cycles. The lower dotted trace shows time intervals of 10 milliseconds.

When a spring is abruptly compressed, its coils may be caused to "surge", that is, the centre coils are displaced relative to the ends to a greater extent than during the slow compression of the spring, and then vibrate.

Normally, the compression of the spring subjects the material to stresses which are well within its fatigue limit. When the spring surges, however, the oscillation of the coils is added to the normal movement. The stress-range to which the material is subjected is enhanced, and may become excessive.

The illustration above is from a research laboratory record of surge in a spring, the wavy lines showing the displacements of individual coils. The stress range in any turn can be deduced by observing the minimum and maximum turn-to-turn distance.



Surge is an ever-present hazard in coil springs which are compressed abruptly, such as tappet or injection pump plunger springs, and research of this type enables it to be guarded against in the design of equipment.

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THE MANUFACTURE AND MANIPULATION OF SEAMLESS TUBES: MESSRS. ACCLES AND POLLOCK, LIMITED.—I.

THE firm of Accles and Pollock, Limited, now forming part of the Tube Investments Group, was founded in Birmingham in 1899, and moved to Oldbury in 1902. It soon became necessary for the company to acquire another site at The Paddock, a short distance away, where there was room for expansion. In the half-century which has passed since the move to Oldbury, the Paddock Works, the headquarters of the company, have extended to cover 45 acres; and another works has been taken over in Oldbury, formerly occupied with railway carriage and wagon building, where equipment has been installed for the production and manipulation of seamless tubes. To-day, the two works cover a total area of about 90 acres, and employ over 5,000 persons.

THE MANUFACTURE OF STRAIGHT TUBES.

The production of the Oldbury works consists of seamless tubes in carbon and alloy steels, stainless steels, and non-ferrous metals and alloys. The size range varies according to the material, but it is generally within the limits of 4 in. to 0·003 in. outside diameter in carbon and alloy steels; 7 in. outside diameter down to the smallest size for which there is a commercial application (0·0017 in. outside diameter) in the stainless steels; and $\frac{5}{8}$ in. outside diameter to the smallest sizes called for in the non-ferrous metals. The latter group includes, besides brass, copper and aluminium alloys, the nickel alloys made by Messrs. Henry Wiggin and Company, Limited, under the trade names of Monel, Inconel, and Nimonic. The tube mills produce circular and special-section tubes—about 2,000 special sections are listed as standard products; special tubes having very thin walls in relation to the outside diameter (as used, for example, in making thermostat bellows); small-bore thick-walled tubes, including oval and flattened tubes for Bourdon gauges; and multi-bore tubes. Heat treatment and surface finishing, both internal and external, are carried out to users' requirements.

The raw materials of the Oldbury works are short thick-walled seamless tubes of the appropriate material specification, supplied by other factories of the Tube Investments Group. These are variously termed "blooms," "hollow blooms," or, more generally, "hollows." They are reduced to the required finished size by one or more of four methods, namely, plug drawing, mandrel drawing, sinking, and cold reducing. Mandrel drawing gives the greatest reduction per pass, but requires an extra operation, reeling, to enable the mandrel to be withdrawn from the tube. "Sinking" is the reduction of the diameter by drawing the tube through a die without any form of internal support. Cold reduction is a new development, and involves the rolling of the tube on a mandrel by a pair of circular dies; the machine used is similar in principle to the Pilger mill, but operates as a reducer only, instead of as a piercer.

THE PROCESS OF DRAWING.

The first operation in drawing a tube is "tagging," in which the end of the tube is reduced in size to enable it to pass through the drawing die. This is done hot, the tube end being heated in a small oil-fired or gas-fired furnace and then worked down under a Ryder hammer, with progressive tooling in the case of the smaller sizes. Larger tubes are tagged under a pneumatic hammer, as shown in Fig. 1, herewith. After tagging, the tube is dipped in a tank of lubricant, and is then ready for drawing. Three types of draw bench are used: the traditional type, which is non-automatic; the semi-automatic, which is a modification of the traditional type; and the automatic, in which all the operations are mechanised, and controlled by push-button from a central station. All three types of draw bench are basically the same, being provided with a drawing die of the appropriate size and shape, a die holder, and means for gripping the tagged end of the tube and drawing it through the die. The traditional type of draw bench, illustrated in Fig. 2, requires two operators, a "drawer" and a "dogger." The drawer, as his name indicates, is the man in charge, and the dogger is generally a youth who is learning the trade. His duties include attaching the "dog" or gripper to the tube tag, releasing it at the conclusion of the drawing pass, and returning the dog carriage ready for the next pass. He also assists generally at the draw bench. This type of draw bench has undergone no fundamental change over a very long period, but still it has many uses. It is capable of mandrel drawing, plug drawing or sinking, and its drawing speed can be varied from 10 ft. to 150 ft. per minute, as required. Short production runs can best be accommodated on this type of machine, since the tooling and setting are relatively simple, and the change-over can be effected quickly. As two operators are needed in any case, it is customary to set up on this type of draw bench any work which is too heavy for one man to handle. It is also used for drawing short lengths of tube.

The traditional type of draw bench can be semi-

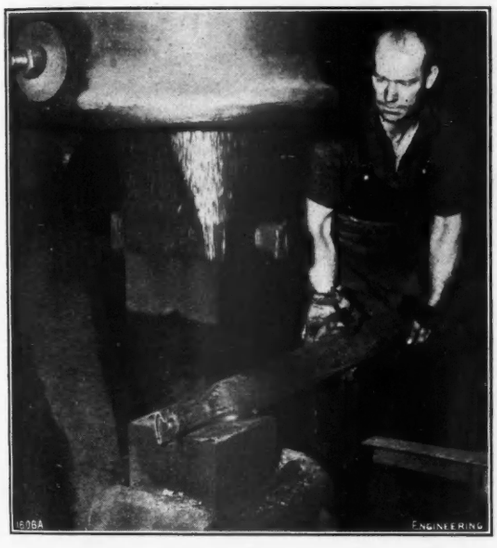


FIG. 1. "TAGGING" A TUBE UNDER A PNEUMATIC HAMMER.

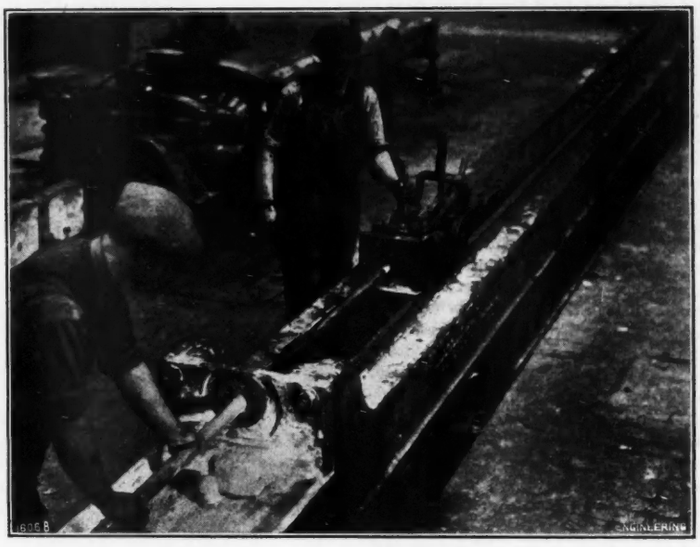


FIG. 2. TRADITIONAL TYPE OF DRAW BENCH, WITH DRAWER AND "DOGGER."

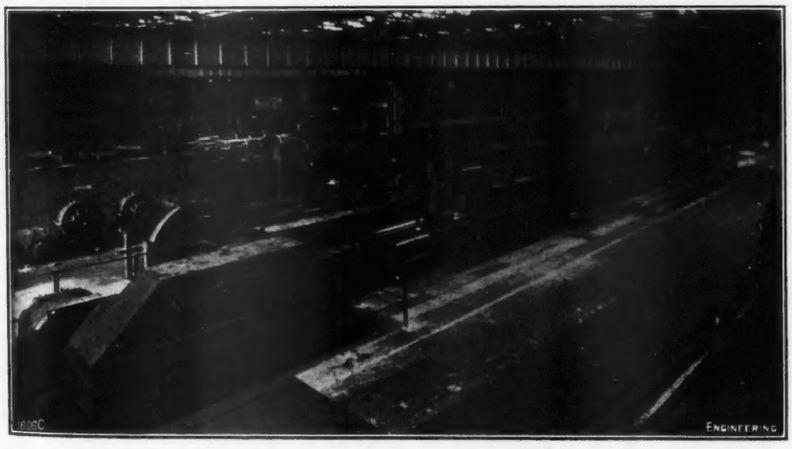


FIG. 3. AUTOMATIC DRAW BENCH.

mechanised, and the dogger eliminated, by means of a cord-controlled dog release which is operated by the drawer when the tube has passed through the die. The dog carriage is then returned to its starting position by a counterweight. For certain types of work this is an advantage, as the labour costs are lower. It is not suitable, however, for heavy work, where two men are needed to handle the tubes, nor does it possess any advantage when short lengths of tube are being drawn. The drawer has to insert the plug bar or mandrel into the tube, and he does so while the bench is drawing the tube that he has prepared previously. If the tube is short and the drawing time consequently brief, any advantage gained by the rapid semi-automatic return of the dog carriage is lost, since the bench must stand idle while the drawer is preparing the next tube. Broadly speaking, the uses of the two types of draw bench, traditional and semi-automatic, can be summed up by saying that the semi-automatic type is used for tubes of relatively light weight and of reasonable length; long production runs are also desirable. The traditional type is better for short production runs, heavier tubes, and short lengths.

For the longest production runs of all, the automatic type of draw bench is used. This also requires the services of one operator, but all the movements are mechanised, and are controlled, as stated, from a central station. More than one type of automatic draw bench is used at the Oldbury works, but the Aetna-Standard, made by Head, Wrightson and Company, Limited, which is shown in Fig. 3, on page 161, and Fig. 4, on this page, is typical. It is based on a draw bench of traditional pattern, but all the operations of feeding, threading of mandrel or plug bar, dogging, drawing, and releasing the drawn tube are mechanised. Tubes for drawing are loaded by an overhead crane on to a sloping rack, which is visible in Fig. 4. From this rack they are fed into one of two tubular guides which lead them down over the mandrel or plug bar. These guides are elevated in turn to the feed rack, and lowered to a position where the tube is in line with the drawing die. The tagged end is then fed forward through the die and gripped by the dog, a close-up view of which is shown in Fig. 5, herewith. Drawing then commences at a speed of 30 ft. per minute, the machine accelerating automatically to the maximum drawing speed, which may be 150 ft. per minute or more, according to the material and conditions. The machine reaches its maximum speed in a distance of 8 ft. and holds it until the pass is finished, when it stops. As the dog carriage travels along, throw-off arms swing across the bed of the machine automatically, ready to pass the tube over the bed when it is ejected from the machine. Some of these arms can be seen in Fig. 5. At the conclusion of the pass, the dog is released, the tube is ejected sideways into a reception area on the floor, the dog carriage returns, striking the throw-off arms as it travels and returning them to their rest positions, and the cycle recommences. The Aetna-Standard machine is capable of drawing a tube 60 ft. long, the longest length made in the factory. It has a high rate of output, and is particularly suitable for long production runs.

The latest method of tube drawing, namely, cold reduction, is carried out on a machine made by Maschinenfabrik Meer A.G., of München-Gladbach, Germany, to an American design. Strictly speaking, the process is not one of drawing, but of rolling on a mandrel. Production rates are very high, one pass on this machine being the equivalent of two or three passes on a draw bench. The tube, with a mandrel inserted, but not tagged—this operation being unnecessary—is fed forward in a series of steps by hydraulic power. At the end of each forward movement the tube pauses, while a reciprocating head rolls a pair of circular dies

MANUFACTURE OF SEAMLESS TUBES.

FIG. 4. "AETNA-STANDARD" AUTOMATIC DRAW BENCH.

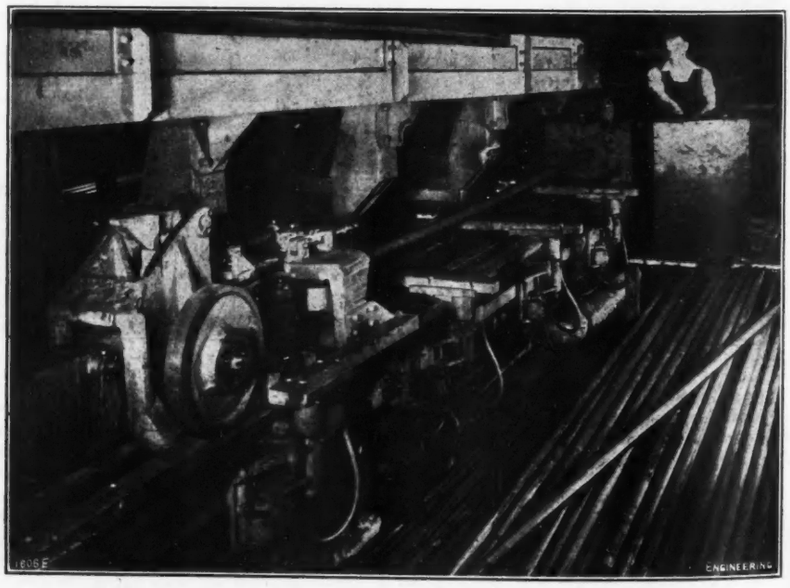


FIG. 5. "AETNA-STANDARD" DRAW BENCH: DOG CARRIAGE AND THROW-OFF ARMS.

MANUFACTURE OF SEAMLESS TUBES.

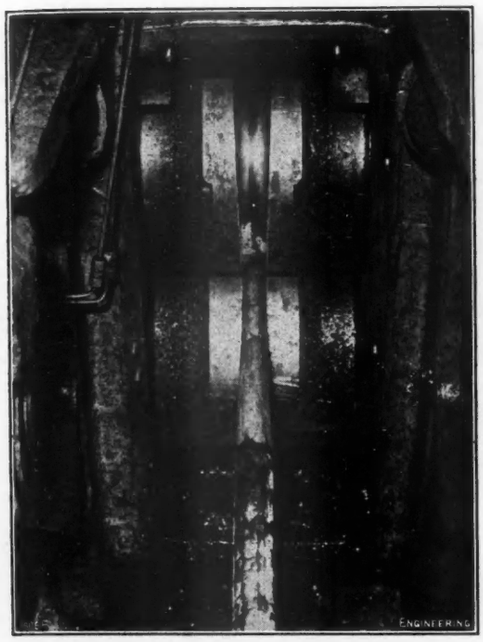


FIG. 6. DIES OF MEER COLD-REDUCTION MACHINE.

FIG. 7. REELING A MANDREL-DRAWN TUBE.

FIG. 8. TUBE-ANNEALING FURNACES.

FIG. 9. ANNEALING-FURNACE CHARGING MACHINE.

over it. Fig. 6, on this page, shows the dies clearly. As will be seen from the illustration, they are similar to those used in a Pilger mill, each having a groove of constantly decreasing radius. The tube is fed forward to the dies when they are in such a position as to present the widest parts of the matching grooves to it. As the dies are rolled forward by the reciprocating head, the narrowing grooves roll the tube down on to the mandrel, so effecting the required reduction in diameter. When the dies have done their work on the length of tube accessible to them, they are rolled back, and the tube is again fed forward into the widest parts of the matching grooves. So the cycle proceeds, until the whole length of the tube has passed through the machine. The Meer machine reduces the number of passes required to effect a particular reduction in diameter, which has the advantage not only of increasing the production rate, but also of reducing the number of inter-pass annealings required. This is desirable on all types of material, and particularly so in the case of the more expensive materials such as the stainless steels, as the material losses due to annealing are reduced. Cold reduction is essentially a long-run process, since re-tooling is a fairly lengthy operation, and the cost of making the special dies is high.

CHOICE OF DRAWING METHODS.

In the drawing of tubes there is, in all cases except that of the cold-reduction machine, a choice of three possible basic methods, namely, plug or mandrel drawing, or sinking. Which of these particular methods is used depends upon the circumstances, as they all have their special features. Mandrel drawing may be considered first, as it is the method most used in the Oldbury works. It has the advantage of giving a bigger reduction per pass than either of the other two methods, and, in addition, the tubes come from the draw bench straighter, and with the bores better planished. It does, however, involve an extra operation, reeling (Fig. 7), for the tube closes on to the mandrel during drawing and must be expanded before the mandrel can be withdrawn. When the tube has been expanded by reeling, it is difficult to forecast

exactly what the diameter will be, so mandrel drawing is not suitable for a finished pass. Its major use is for stock-reduction, that is, drawing down as rapidly as possible to very near the finished size, the finishing pass or passes being given by a different method. The mandrels are of nickel-chrome-molybdenum steel, air-hardened. They are finished to size by centreless grinding, and therefore are rather costly to produce.

Plug drawing, in which the tube is drawn over a plug of the required diameter, held in the die by a plug-bar from behind, has the advantage that it is faster than mandrel drawing in overall time, since the tube is drawn right off the plug and there is no subsequent reeling operation. It is not possible to obtain such a great reduction per pass as when a mandrel is used, but plug drawing scores on the ground of speed, and also because the tooling is cheaper. Only a short plug, a little longer than the die width, is used, and this alone has to be finished to close limits. The bar which retains it in position in the die need only possess the requisite physical strength; its surface finish and metallurgical composition are unimportant. The plugs, which are screwed on to the plug bars, are either of tungsten carbide, as is usually the case with the dies, or else of alloy tool-steel, with a hard chromium finish.

Finally, there is sinking, that is, drawing through a die without any form of internal support to the tube. This has an obvious application where the tubes are of such small diameter that internal support is impracticable; hypodermic tubes provide an example. Plug drawing can be carried out down to about $\frac{1}{4}$ in. inside diameter, and mandrel drawing down to about 0·03 in. bore or less. Below these limits, sinking is the only possible method. Sinking also has the advantage that it is the simplest and fastest method of tube drawing, and it is by no means confined to the very small sizes. It has the disadvantage that there is no control over the bore, and that large reductions per pass are not practicable. It is used where the bore surface is unimportant, and for certain sizing and finishing passes. For example, a mandrel-drawn tube, the diameter of which cannot be guaranteed when it comes off the reeling machine, may be sunk to its finished size in one pass. Sinking is also used extensively for changing the shape of tubes, e.g., from round to oval. It should be added that, though sinking does not normally afford means of controlling the bore, it is possible, by a special technique, to produce bores of great accuracy and high finish by sinking, and the very small-bore tubes, which can only be produced by this method, are drawn to very fine limits. Sinking is also used for the production of composite tubes, such as, for example, a carbon-steel tube with a stainless-steel liner, and for multi-bore tubes, where an outside tube is sunk on to a group of smaller ones.

It is generally necessary, after each pass, to anneal the tube to relieve the stresses set up by the drawing. This is always done cold, except in cases where the particular physical properties produced by cold working are called for. In such instances the inter-pass annealings will be omitted during the last few passes. Annealing of tubes is carried out in batches in gas-fired or oil-fired furnaces, such as that in Fig. 8, on page 163, with a ground-type charging machine (Fig. 9, on page 163), served by an overhead crane. Scale removal after annealing is done by bulk pickling, in machines designed for the purpose. A chain cradle (Fig. 10) is suspended over the pickling vat. Tubes are loaded on to the machine by an overhead crane and rolled into the chain cradle, which is then lowered into the pickling vat and mechanically agitated. When the pickling is completed, the cradle is lifted and the tubes are removed by the crane.

MANUFACTURE OF SEAMLESS TUBES.

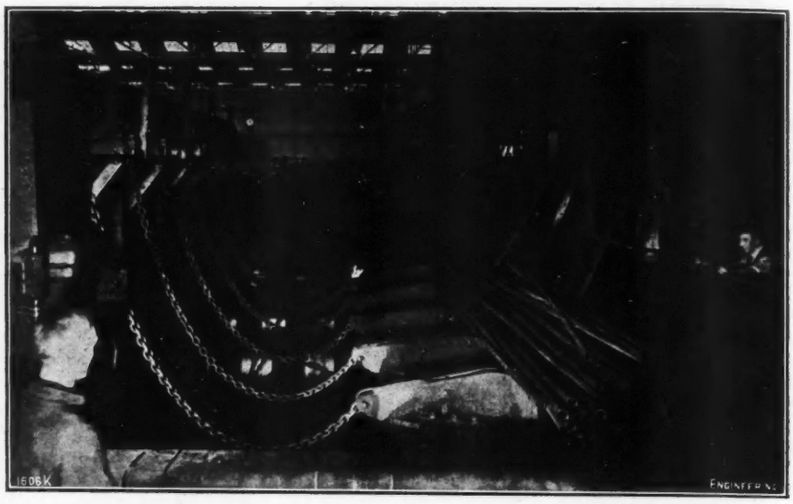


FIG. 10. MECHANICAL PICKLING VAT.

FIG. 11. SEMI-AUTOMATIC CUTTING-OFF MACHINE.

The products of the draw benches are all straight tubes. The variety is considerable, and includes plain round tubes, squares, hexagons and other special sections, and "jack-bore" tubes. The latter are plain round tubes in the production of which special attention is given to the bore finish. They were originally produced for the makers of hydraulic jacks—hence the name—and have bores which are of such accuracy, and with such a highly planished finish that they can be used for jack manufacture without any further internal processing. Jack-bore tubes have the greatest degree of accuracy which can be produced by drawing alone; greater accuracy is possible, but it involves extra processing.

All tubes leaving the mill are accurate as regards size and material specification, but they are in random lengths. In this condition they are passed to the warehouse, where they are prepared for despatch to customers. Frequently, random lengths are ordered, and in this case, no further work on the tubes, other than cutting off the tagged ends, is required. Semi-automatic machines, shown in Fig. 11, on this page, are provided for this purpose, and the same machines are used for cutting to length as ordered. The warehouse is equipped to carry out numerous other finishing processes, in addition to cutting to length; these include heat treatment and straightening. Open annealing is the commonest form of heat treatment used in the Oldbury works. Tubes which have subsequently to undergo severe bending or other manipulation are usually open-annealed, the process being carried out in gas-fired or oil-fired furnaces of orthodox type. Open annealing leaves a certain amount of scale, which may or may not be of importance to the particular user. If it is not acceptable, close annealing, in which the tubes are heated in sealed pots, is available as an alternative. This ensures freedom from scale, but a very small amount of oxide on the surface is unavoidable. To overcome this difficulty, special inert-atmosphere furnaces are used, either with roller-conveyor feed, as in Fig. 12, on page 176, or with a wire-mesh conveyor feed. Furnaces are also provided for heat-treating tubes to produce any physical characteristics of which the particular material is capable. Among the plant in this category is the vertical electric furnace shown in Fig. 13, on page 176. It is installed directly over an oil tank, for vertical quenching.

Finally, there is straightening. By the use of

suitable drawing techniques, and by close attention to the process, it is possible to produce, straight from the draw bench, tubes which are sufficiently accurate for many purposes. The usual straightness tolerance is 1 in 500, i.e., a tube may deviate from straightness by 1/500th of its length. In some cases, such as tubes used for propeller shafts, and other high-speed rotating components, this is not sufficient; for closer tolerances of straightness than drawing will provide, a press-straightening operation is performed. By this means, accuracy to within a thousandth part of the length is possible, and, in certain circumstances, a figure of one ten-thousandth has been achieved. It is a matter of interest that, for a few special purposes, such as the manufacture of certain sporting goods, the final straightening is carried out by hand and eye, as shown in Fig. 14, on page 176, in the same way as rifle barrels have been straightened for very many years.

LITERATURE.

S.S. Ocean Vulcan Sea Trials: The Forces Acting on the Ship at Sea.

Report No. R.8 of the Admiralty Ship Welding Committee. H.M. Stationery Office, York House, Kingsway, London, W.C.2. [Price 35*s.* net.]

WHEN the all-welded tanker Schenectady broke in two while lying in a fitting-out berth in June, 1943, the shock, it has been said, was felt in shipping and shipbuilding circles throughout the world. Reports of other, but less disturbing and spectacular, failures in welded ships indicated the necessity for a thorough investigation into the cause of the casualties, and the Admiralty Ship Welding Committee was formed in Great Britain and a Board of Investigation set up by the Secretary of the United States Navy with this end in view. The casualties which caused so much concern were suffered in merchant ships which were entirely or almost entirely welded, and therefore, in the first examination of the problem, it was thought that the trouble might lie in the new mass-production methods which had been adopted in these American-built welded ships. The investigations made by the Admiralty Ship Welding Committee were conducted, therefore, under the broad headings of design, with particular reference to the difference in structural behaviour between welded and riveted ships, workmanship and materials. In fact, the early failures are now known to have been related to an important extent to the steel used in the ships, which, in the presence of stress-raising notches, was found to fracture in a brittle manner. In the pursuit of the reasons for the failures of welded ships, however, a large part of the research effort on both sides of the Atlantic was devoted to investigating whether there was some essential difference between the structural behaviour of welded and riveted ships. As a preliminary step, the Admiralty Ship Welding Committee carried out a full-scale hogging and sagging test in still water on the S.S. Empire Duke, an all-riveted merchant ship of about 10,000 tons deadweight, by arranging the sequence of loading a coal cargo, and by shifting water ballast. Subsequently, in the summer of 1944, a more ambitious experiment was carried out on the 12,000-tons deadweight all-welded tanker Neverita, where, by shifting water ballast in the cargo tanks, a number of loading conditions, ranging from extreme hogging to sagging, was obtained. Subsequently, similar experiments were carried out on a mainly-riveted sister ship, the Newcombia, and it was found that there was no important difference between the behaviour of the two ships which would account for the fractures in welded vessels.

It was felt, however, that such trials in still water did not give a complete answer to the problem, and that a comparison of the behaviour of a riveted and a welded ship at sea should be made. At first sight, an attractive solution was to send a pair of ships to sea in company, and to compare the stresses sustained by each, but further examination of the matter showed that, even under the most favourable conditions, it could not be expected that both ships would behave in an identical manner. It was therefore decided that the forces imposed by the sea on one ship, and the response to similar forces imposed in still water on two sister ships, one all-welded, and the other all-riveted, should be measured. The complete investigation, therefore, consisted of extensive still-water bending tests on two ships, the all-welded Ocean Vulcan and the riveted Clan Alpine, and sea trials on the Ocean Vulcan. The results of the sea trials on the Ocean Vulcan have already been reported in vol. 91 (1949) of the *Transactions* of the Institution of Naval Architects, and now the Admiralty Ship Welding Committee have produced their Report R.8, on these trials, which incorporates and elaborates the information given in the *Trans. I.N.A.*; the reports on the still water experiments of the Ocean Vulcan and the Clan Alpine are in the course of preparation. The additional matter in Report R.8 consists mainly of a discussion on the general behaviour of ocean waves, an account of earlier work on strain measurement at sea, and an exposition of the methods employed in the analysis of the longitudinal bending moments and other actions. There is also a theoretical investigation on the effect of wave heights and lengths on the bending moments, and an appendix dealing with the influence of the dynamic forces and ship's movements.

These sea trials of the Ocean Vulcan consisted of eight round voyages across the North Atlantic, outward in ballast and homeward loaded, between December, 1945, and May, 1947. The conditions encountered in six of the voyages were similar, with a maximum range of stress, measured at the top of the sheer strake amidships, of 3 tons per square inch; one voyage was much rougher, with stress ranges up to 8 tons per square inch, and one much calmer. Records were taken on about 75 per cent. of the total days that the vessel was on the open ocean, and these included water pressures and wave profiles taken at 12 sections along the ship, accelerations, angles of roll, pitch and yaw, stresses on a transverse section near amidships, and surveys of wave heights by stereoscopic cameras. The main conclusions (which, as is pointed out in the report, apply to the Ocean Vulcan, and not necessarily to ships of other forms and dimensions) are as follows. In the first place, it was found that the greatest range of vertical bending moment derived, corresponding to a range of stress of 8 tons per square inch, was associated with waves 35 ft. high and between 600 ft. and 700 ft. long. According to oceanographical data, waves of even greater severity may be encountered, but it is estimated that the maximum range of stress likely to be experienced is 11 tons per square inch.

Slamming action caused stress ranges up to $\pm 1 \cdot 5$ tons amidships, and, in the few cases observed, these increased the peak sagging stresses, but not the peak hogging stresses. Horizontal bending moments were observed in most wave conditions, with a maximum range of $2\frac{1}{2}$ tons per square inch; these horizontal bending moments, it was considered, might be in phase with the vertical bending moments. Torsion moments were small, a result which confirms the considerations advanced by Dr. G. Vedeler, in his paper on "The Torsion of Ships" (*Trans. I.N.A.*, vol. 66, 1924). Theoretical considerations, supported by the experimental evidence, show that the dynamic terms in the determination of vertical bending moments at amidships tend to cancel each other, and the Committee conclude that, in consequence, a reliable estimate of the sea bending moments can be made from the assumption that the ship is in static equilibrium on the wave, provided that the Smith correction is applied.

These findings are of great interest and importance to naval architects, and the conclusion that the dynamic forces, and, in particular, the "Read correction" for heaving may be neglected, will be received with relief. The estimate of the range of stress due to the passage of the wave confirms the results obtained by Schnadel, as reported to the Schiffbau Technische Gesellschaft in 1936; but his opinion that, when the ship is on the crest of a wave, the stresses imposed correspond to a lesser wave height than when she is in the trough, is not substantiated.

It is unfortunate, perhaps, that some of the theoretical work in this report was not ventilated in the transactions of one of the technical societies, as their authority would have been enhanced after submission to discussion. No doubt, further examination will be made before they assume canonical authority. Meanwhile, the data have been presented in a full and clear form, and the conclusions reached seem to be well founded. The Admiralty Ship Welding Committee, in the foreword, point out that the draft of the report was prepared by Mr. F. B. Bull, who was associated with the trials from their inception, and that the theoretical considerations in the appendix were developed by him. It is evident that much credit is due to Mr. Bull for his part in this work, and also that the main Admiralty Ship Welding Committee have been well served by the sub-committee responsible. It is an interesting reflection that, had the importance of the quality of steel and the detail design in welded ships been realised earlier, these monumental trials might not have been carried out; in which case, the science of naval architecture, as it concerns the strength of ships, would have been deprived of an investigation not likely to be repeated in these times. Furthermore, it is remarkable that the period between the formation of the Admiralty Ship Welding Committee and the inception of the experiments was much shorter than that between their conclusion and the publication of the report.

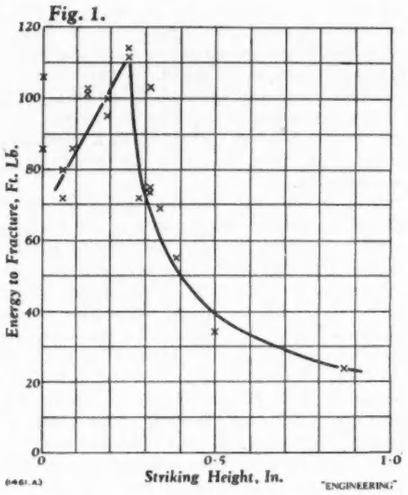
Lubricant Testing.

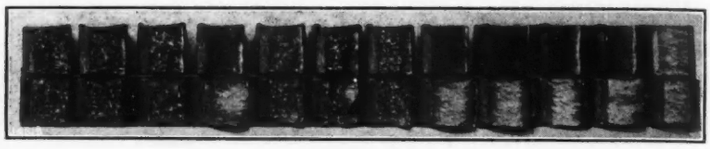
By E. G. ELLIS, B.Sc., F.Inst. P. Scientific Publications (Great Britain), Limited, 8, Walker-street, Wellington, Shropshire. [Price 37*s.* 6*d.* net.]

WHILE it is difficult to compare with any accuracy evidence of the present day with memories of many years ago, there can be no doubt in the minds of users of lubricants that there have been great improvements in the past two decades in the precision with which the properties of engineering lubricants are now determined and the uniformity that can be commercially maintained; a result which is highly creditable to the producers, bearing in mind the many sources from which their supplies are drawn. The methods and apparatus employed to that end form the subject of this book, which reviews in detail the many types of instrument that have been developed, the tests that have been established, and the molecular structures, composition, properties and behaviour which characterise the lubricants in general use. The survey is not confined to oils and greases, but includes also metallic soaps, etc., used for special applications. It is designed to meet the practical requirements of a wide variety of possible readers, not all of whom can be expected to possess expert knowledge of the chemistry and physics of the subject, but those who do possess it in some measure are likely also to find the book of service as a work of reference to the apparatus now available, some of which, it is claimed, is here described for the first time in any text-book. It seems a little curious that graphite does not figure in the index; and no mention appears to be made of the Michell cup-and-ball viscometer, a device which, perhaps, in all but the most expert hands, was to be regarded rather as an approximate comparator.

THE IZOD TEST IN GEAR DESIGN AND PERFORMANCE.

Fig. 1.





Striker Height.											
0·86″ (Izod)	0·38″	0·34″	0·31″	0·31″	0·28″	0·28″	0·25″	0·19″	0·13″	0·09″	0·06″
Foot-Pounds.											
32	55	69	103	73	88	81	113	100	102	86	71

Fig. 2. Selection of Fractures.

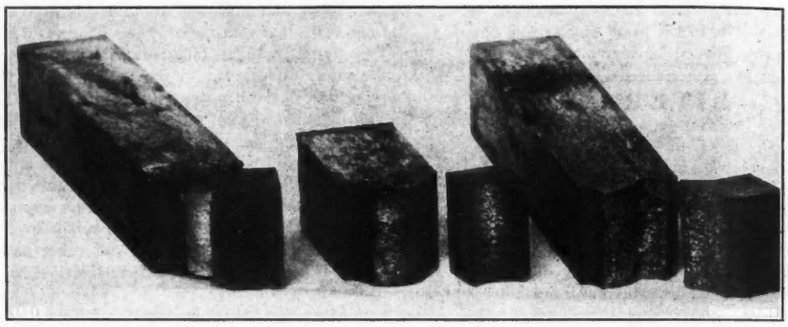


Fig. 4. Fractures of Special Test-Pieces.

Fig. 3.

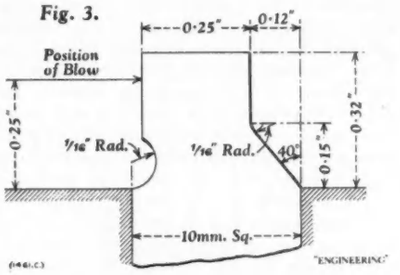
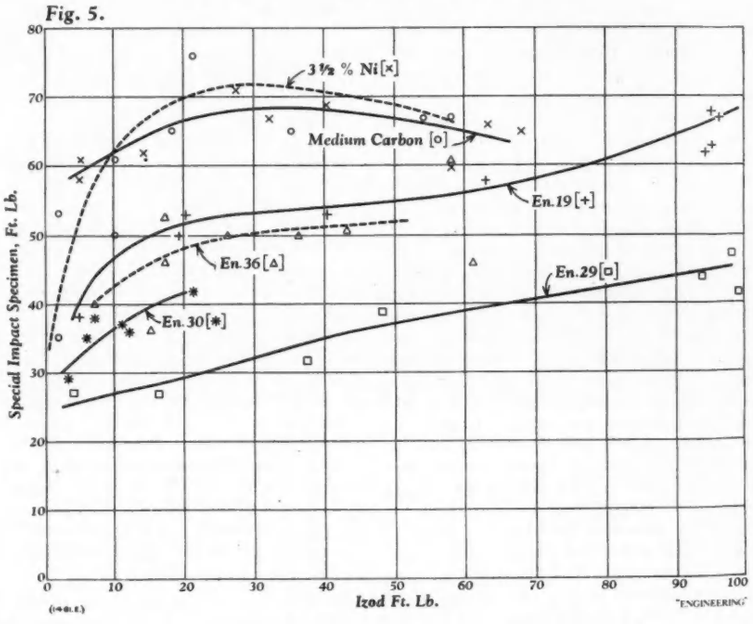


Fig. 5.



THE SIGNIFICANCE OF THE IZOD TEST WITH REGARD TO GEAR DESIGN AND PERFORMANCE.

By J. E. Russell, M.A., and W. T. Chesters, A.I.M.

It has long been realised by engineers that the Izod, or any other impact test, is of little use for purposes of design. The stress-system at the bottom of the notch and the rates of application of the load are so very different from what generally occur in practice under "shock" conditions, that the energy absorbed is no indication of what might occur in service. Further, there is a fairly large body of work showing that the impact-test value is quite unrelated to fatigue properties, at least for stresses in the region of the fatigue limit. Inglis[1*] showed that no change of fatigue properties occurred in a Ni-Cr steel, having an original Izod value of 38 ft.-lb. after high-temperature embrittlement for many years, producing an Izod value of 4 ft.-lb. Collins and Dolan[2] could find no correlation between the Izod value or tensile ductility and fatigue (plain and V-notched specimens) on a series of carbon and low-alloy steels, and more recently Gough[3] also reported little correlation, using specimens with sharp notches, producing stress-concentration factors of up to 10.

Under conditions of fatigue under shock loading, or "smooth" loading at such a rapid rate that it can be regarded as shock, the main information in the literature appears to be that of Stanton and Bairstow[4] who used the old repeated-impact test, now unfortunately discarded, and showed that where the energy of the repeated blow was in the neighbourhood of the fatigue limit of energy the lives of the specimens were in strong correlation with the ordinary fatigue limit of smooth specimens determined on the Wöhler machine and independent of the Izod value of the material, but when blows of a very high energy were given, so that the specimens broke very quickly, the lives were strongly correlated with the Izod value. It would therefore appear that, from a somewhat academic point of view, there is in general little to fear from low impact values in so far as the possibility of failure by fatigue is concerned.

There remains the possibility of the failure of a structure at one sudden application of an excessive overload, and here, in contrast to fatigue failure, no general statement can be made on the relevance of a standard impact test; each problem must be considered on its own merits. While it must be admitted that there is often little evidence on which to base such consideration, it is equally true that engineers have been prone to allot too large a safety margin to cover their ignorance, and to ask for material of high Izod value simply because shock loading (of any kind) would be occurring on the structure they were designing.

Shock Loading of Gears.

With regard to the specific problem of gear design and performance, there have been widely divergent views expressed, from time to time, on the efficiency of a high Izod value to guard against tooth-breakage by shock loading. On the one hand, Bailey[5] in England, and Almen and Boegehold[6] in America, hold that a low Izod value is the least of any defects of the steel. Tooth-breakages due to low Izod values alone are non-existent; many gears go into service with Izod values below 10 ft.-lb. but give quite satisfactory "lives" under very heavy shock conditions. On the other hand, McMullan,[7] Rowe[8] and others emphasise the necessity for material of high Izod value to ensure

* These figures relate to a list of references to be found at the end of the article on page 169.

THE IZOD TEST IN GEAR DESIGN.

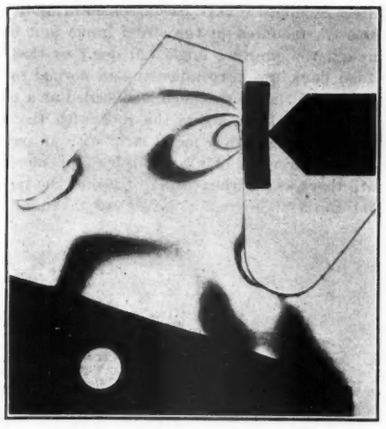


FIG. 6. 9 D.P. BASIC-RACK TOOTH FORM.

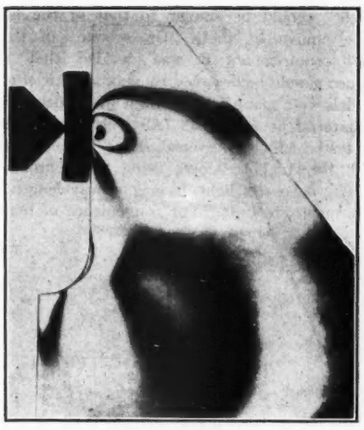


FIG. 7. MODIFIED 9 D.P. TOOTH FORM.

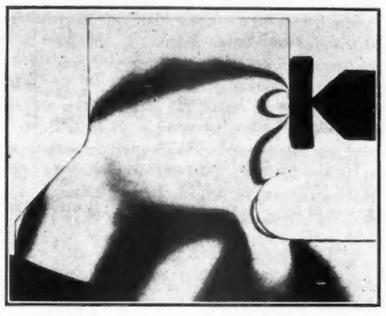


FIG. 8. TOOTH FORM WITH STRENGTHENING PAD.

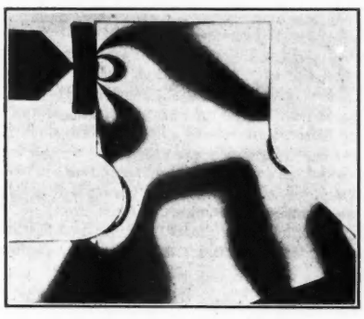


FIG. 9. TOOTH FORM WITH MODIFIED NOTCH.

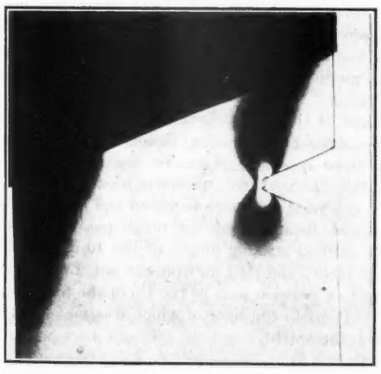


FIG. 10. STANDARD IZOD SPECIMEN.

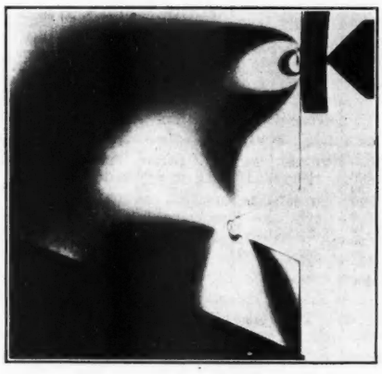


FIG. 11. STANDARD IZOD SPECIMEN.

good performance in gears. In order to throw some further light on this problem, and, if necessary, to devise an impact test other than the Izod which would give some indication of the reaction of a gear to shock loading, an investigation was sponsored by the Admiralty-Vickers Gearing Research Association, Sub-Committee "C," and the results are reported below.

A preliminary examination of the problem showed that the most important design variable influencing the impact value is the ratio of the bending moment to the shear stress across the section of the specimen. An Izod specimen and a gear-tooth are both cantilevers struck at right angles to their length. If the distance from the anvil, or the tooth-root, to the point of application of the blow increases, the bending moment of the applied force increases while the shear stress across the section at any position remains constant. Hence, for a sufficiently long striking distance, the specimen or gear tooth will bend or fracture near the position of fixture, and for a sufficiently short one it will shear off at some position, with probably a very great increase in the energy absorption if the ordinary Izod test is brittle.

A preliminary investigation on Izod tests with variable striking height was made with specimens cut from a carbon-manganese steel forging, normalised and tempered to an ultimate tensile strength of 29 tons per square inch, which was known to have given brittle "crystalline" fractures in the Izod test (24 ft.-lb.). The standard Izod machine was fitted with a striker on the front of the tup in such a manner that the height of the blow above the top of the anvil was adjustable between zero and 1 in. A series of Izod specimens was broken using different striking heights, and the energies to fracture, and the type of fracture were both noted. The results are shown in Table I. Fig. 1, opposite,

TABLE I.

Height of Striker.	Ft./Lb.	Fracture Types.
In.		
0·87 (22 mm.) (Standard Izod)	24	Crystalline.
0·50	34	,,
0·38	55	Almost all crystalline.
0·34	69, 69	Transitional.
0·31	75, 74, 103	,,
0·28	72, 72, 72	,,
0·25	115, 114	Shear.
0·19	95, 100	,,
0·13	103, 101	,,
0·09	86	,,
0·06	80, 72	,,
0	86, 106	,,

shows the energies plotted against striking height, and Fig. 2 is reproduced from a photograph of a selection of the fractures. It will be seen that the energy gradually rises as the striking height falls until a maximum is reached at about $\frac{1}{4}$ in. striking height; at the same time, the fracture changes from a completely crystalline one to a completely shear one. Below $\frac{1}{4}$ in. striking height, all the fractures are shear, but the sheared-surface is very curved for the $\frac{1}{4}$-in. height and this curvature diminishes to almost flat for the lowest striking height. This reduction in curvature, causing a diminution of the actual area of sheared surface, may account for the tendency of the energies to fall as the striking height moves below $\frac{1}{4}$ in. to zero.

It could be concluded from these results then, that a gear made of material as brittle as the one tested above and with a stress-raiser at the root as drastic as an Izod notch, would give satisfactory performance provided that the striking height of the teeth of the mating gear were less than a certain critical amount, and, indeed, that there is an optimum striking height at which such a tooth would display its toughest behaviour.

It was then decided to perform impact tests on a "model" gear tooth, i.e., a type of specimen which would imitate the loading conditions of a typical spur gear tooth, particularly in regard to the stress-concentration factor at the bottom of the tooth and the height of application of the maximum load, but using material of widely different Izod values. After some experimentation with models examined photo-elastically, the specimen shown in Fig. 3, opposite, was decided upon. Details of the work leading to the choice of this specimen are given in the Appendix to this article. The steels used for the tests were chosen from a series which was being examined by the A.V.G.R.A. as possible gear steels. The cast numbers and analyses are given in Table II, on page 168. They were supplied as 1-in. diameter hot-rolled bar, and the heat-treatment and tensile-test results are shown in Table III, page 168. In order to obtain a wide variation of Izod value on these steels, the impact tests were made at different temperatures ranging from room temperature down to — 196 deg. C. (boiling point of liquid nitrogen).

A special pair of Izod anvils was made for these tests, having two bolts joining the two halves so that a specimen can be set up in the anvils away from the machine. The specimen and the anvils in which it was gripped were then all lowered into the refrigerating medium and allowed to soak for half an hour. The whole fixture was then lifted out, slid into the machine, tightened, and the specimen broken in about 3 to 4 sec. The refrigerating medium, below 0 deg. C. and down to —78 deg. C., was solid carbon-dioxide in methylated spirit, and below —78 deg. C. it was pentane in a special container with a double-walled jacket into which liquid nitrogen could be poured as required in order to attain and hold any particular temperature. Temperatures were measured with a copper-constantan thermocouple which was checked

against the freezing point of mercury and the boiling point of liquid nitrogen.

The test results obtained are given in Table IV, and a graph of the results is given in Fig. 5, on page 166. As with the preliminary series above, the specimen showed variation in the mode of fracture and Fig. 4, on page 166, shows the three types obtained. Although most of the curves show a falling tendency for the special test piece as the Izod drops from high values to low ones, there is no drop of any real significance until about 25 ft.-lb. Izod is reached, when the En. 29 material (3 per cent. Cr Mo) has dropped from about 45 ft.-lb. to 32 ft.-lb. It is only below an Izod of 5 ft.-lb., however, that the special test shows signs of a drastic fall which might be of serious consequence in service.

Lest it may be thought that the known rise in the strength of steel as the temperature falls may have affected the results favourably where shear processes are concerned, a series of tests was made with a 1 per cent. Cr steel of the following analysis: carbon, 0·30; silicon, 0·14; manganese, 0·53; sulphur, 0·025; phosphorus, 0·023; nickel, 0·05; and chromium, 0·97. This was hardened and tempered to an ultimate tensile strength of 50 tons per square inch in bar sizes of $\frac{11}{16}$ in., $1\frac{1}{8}$ in., $2\frac{1}{8}$ in., 3 in., $4\frac{1}{4}$ in., and $5\frac{1}{8}$ in., thus giving a range of Izod values at the same tensile level. Izod specimens, and the special impact specimens were made and broken with the following results:—

—	Ft.-Lb.	Ft.-Lb.	Ft.-Lb.
Izod	26–32	18–32	54
Special test-piece	55–58	53–58	50·62
Izod	69–88	84–87	95–96
Special test-piece	53–53	63–63	70–76

Again, the general lay-out of the points is similar to that already obtained by the varying-temperature test.

General Conclusion.

It would appear from the above results that there is little value in requiring gear material to have an Izod value in excess of 5 ft. lb., as far as shock-loading conditions are concerned. On the other hand, as a fair safety margin for very high-duty gears, values of, say, 10 ft.-lb. minimum might reasonably be requested, but this could be justified only for very special examples. In any instance where some doubt may arise as to the suitability of a steel having a low Izod value for the manufacture of a particular gear or set of gears, the authors feel that the special impact test specimen described above would provide a useful guide for the engineers concerned. While the actual energy level itself would not be of direct value, the appearance of the fracture—whether brittle or shear—would be sufficient to indicate whether the material would behave in a brittle or a "tough" manner when made into gears.

The authors are indebted to the Council of the Admiralty-Vickers Gearing Research Association, the directors of the English Steel Corporation, Limited, and Messrs. David Brown (Huddersfield), Limited, for their permission to publish the results reported in this article.

Appendix.

Designing a "Gear Tooth" Impact Specimen by Photo-Elastic Study.

When this investigation was first opened it was agreed that the gear tooth impact specimen should conform to the following requirements. (*a*) That the portion of the specimen above the notch should simulate the largest standard tooth form that could be accommodated on a 10-mm. square specimen; (*b*) that the load should be applied normal to the flank of the "tooth" and at the point which corresponds to that which produces the greatest bending stress in a gear tooth; (*c*) that the amount of energy required to break the specimen should be within the capacity of the 120 ft.-lb. machine; and (*d*) that the stress concentration value of the "notch" should be similar to that of the fillet of the equivalent tooth. On account of these special requirements it was decided that the specimen should be designed by photo-elastic study.

Models were manufactured from $\frac{1}{8}$ in. thick sheet, the material being C.R.39 (Allyl ester resin) and were tested in the universal stress frame on the David Brown polariscope, using monochromatic circularly-polarised light having a wavelength of 5,460 Ångström units. For convenience of manufacture and test, all models were made five times their normal size. A magnification of 1·4 was obtained in the photographic system. A model of British Standard 9 D.P. basic-rack form tooth was prepared, mounted in the stress frame and tilted through the pressure angle (20 deg.) so that the loaded flank was perpendicular and normal to the loading axis. The specimen was loaded at a point on the flank 1 in. above the root with the load transmitted through a metal strip with an outside radius of curvature of 5 in. This load was increased until there was a fringe order of two at the tension fillet and a photographic record was taken.

TABLE II.

Steel.	Cast No.	Analyses. C	Si	Mn	S	P	Ni	Cr	Mo
		Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Med. carbon	30266	0·25	0·16	0·67	0·040	0·036	0·14	0·05	0·03
3½ per cent. nickel	28577	0·34	0·24	0·62	0·060	0·034	3·63	0·12	0·02
En. 19	H.G. 6122	0·38	0·23	0·60	0·016	0·029	0·21	1·09	0·32
En. 29	H.H. 1260	0·21	0·15	0·47	0·016	0·013	0·17	3·09	0·51
En. 30	O.C. 3885	0·30	0·21	0·51	0·011	0·019	4·10	1·17	0·09
En. 36	O.C. 2479	0·13	0·20	0·39	0·030	0·030	3·30	0·85	0·09

TABLE III.

Steel.	Heat Treatment.	Tensile Tests. Limit of Proportionality.	Proof Stress. 0·05	0·1	0·2	0·5	Ultimate Tensile Strength.	Elongation.	Reduction of Area.	Izod.
		Tons Per Sq. In.	Tons Per Sq. In.	Tons Per Sq. In.	Tons Per Sq. In.	Tons Per Sq. In.	Tons Per Sq. In.	Per Cent.	Per Cent.	Ft.-Lb.
Med. carbon	Normalised 850 deg. C./A.C.*	22	Yield point 22·6				34·6	34·	61·9	56, 60
3½ per cent. nickel	840 deg. C./O.Q. T. 670 deg. C./A.C.	27	33·7	34·4	34·8	35·5	49·8	24·3	47·4	—
En. 19	860 deg. C./O.Q. T. 720 deg. C./A.C.	40	Yield point 41·7				48·2	27·6	67·6	93, 97
En. 29	900 deg. C./O.Q. T. 600 deg. C./A.C.	40	49·0	50·7	52·3	54·5	60·5	21·5	70·9	92, 95
En. 30	820 deg. C./A.C. T. 525 deg. C./A.C.	45	65·5	67·6	69·4	71·0	75·8	17·8	54·4	11, 12
En. 36	860 deg. C./O.Q. 770 deg. C./O.Q. T. 200 deg. C./A.C.	14	34·8	40·5	46·4	54·2	65·4	19·0	60·8	58, 63

* A.C. = air-cooled; O.Q. = oil-quenched; T. = tempered.

TABLE IV.

Temp.	Med. Carbon Steel. Special Test Piece.	10 mm. Square, Izod.	Temp.	3½ Per Cent. Nickel Steel. Special Test Piece.	10 mm. Square, Izod.
Deg. C.	Ft.-Lb.	Ft.-Lb.	Deg. C.	Ft.-Lb.	Ft.-Lb.
+ 100	65	68	+ 60	67	58
+ 30	66	63	+ 20	67	54, 54
+ 20	60, 60	56, 60	— 50	76	21
+ 3	69	40	— 60	65	35
— 10	67	32	— 125	65	18
— 30	71	27	— 150	61, 61	10
— 50	62	14	— 160	50, 49	10
— 77	61	5	— 196	53, 35, 66	2
— 100	58	5			

Temp.	En. 19 Steel. Special Test Piece.	10 mm. Square, Izod.	Temp.	En. 29 Steel. Special Test Piece.	10 mm. Square, Izod.
Deg. C.	Ft.-Lb.	Ft.-Lb.	Deg. C.	Ft.-Lb.	Ft.-Lb.
+ 20	58, 68	93, 97	+ 20	40, 48	92, 95
— 25	67	96	0	46, 49	96, 100
— 50	68	95	— 25	42	99, 99
— 77	62, 62	94	— 100	37, 41	48
— 95	58	63	— 120	32	37
— 112	53	40	— 150	27	16
— 130	53	20	— 196	25, 29	4
— 150	50	19			
— 196	38	5			

Temp.	En. 30 Steel. Special Test Piece.	10 mm. Square, Izod.	Temp.	En. 36 Steel. Special Test Piece.	10 mm. Square, Izod.
Deg. C.	Ft.-Lb.	Ft.-Lb.	Deg. C.	Ft.-Lb.	Ft.-Lb.
+ 100	42	21	+ 20	49, 67	58, 63
+ 20	36	11½, 12	— 40	49, 52	36, 50
0	37	11	— 60	50, 51	29, 41
— 42	37	7	— 77	47, 53	21, 32
— 77	35	6	— 100	52, 53	17
— 100	31	4	— 130	46	17
			— 150	36	15
			— 196	38, 42	7

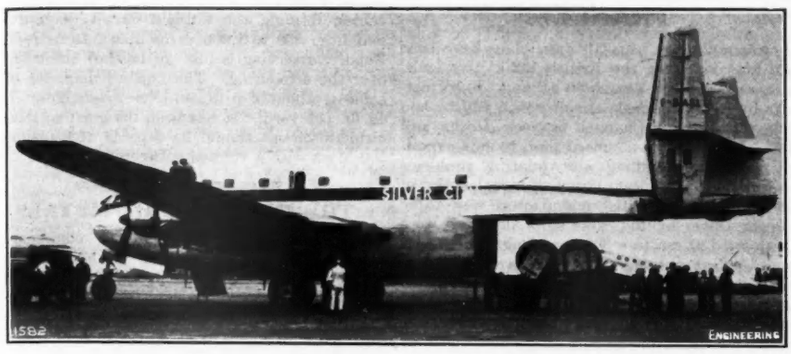
Several specimens, the designs of which were based on the 9 D.P. tooth, were prepared and tested in a similar manner. As before, the load required to produce a fringe order of two on the tension "notch" were noted and photographic records taken of the specimen under load. In order that the stress-concentration factors and load values of these specimens might be compared with those of the standard Izod specimen, models of the latter (× 5 normal size) were prepared and loaded: (*a*) at normal distance from the notch (corresponding to the normal striking height of the 10-mm. sq. Izod test piece), and (*b*) 1 in. from the notch (corresponding to a position near to the tip of the hypothetical 9 D.P. tooth the fillet of which was made to blend with the notch).

The stress-concentration factor is normally taken as the ratio of true maximum stress as determined by photo-elastic analysis, to the stress calculated by the ordinary equations of mechanics using the net section but ignoring the changed distribution of stress due to the effect of shape.

Values obtained in this way are given in Table V, opposite, and Figs. 6 to 11, on page 167, are the photographic records of the loaded specimens.

Specimen No. 1, shown in Fig. 6, is the model of a 9-D.P. B.S. basic-rack tooth form inclined at an angle of 20 deg. and having the upper portion of the following tooth cut away to facilitate normal loading. Specimen No. 2 (Fig. 7) is the 9-D.P. tooth form modified for the impact specimen. A small projection has been removed from the rear and a little extra left on top. Not only does this increase the stress concentration factor, but practical breaking tests indicate that the specimen is liable to shear at half depth. Specimen No. 3 (Fig. 8) is based on the inclined 9-D.P. tooth form, but a strengthening pad has been added to the loading

AIR CAR-FERRY DEVELOPMENTS.



flank and a triangular piece taken from the rear base and added to the rear flank. Although the indications are that the specimen should break correctly, the stress concentration factor is too high. Specimen No. 4 (Fig. 9) is similar to No. 3 except that the radius of curvature of the notch has been increased and the section relieved. In order to counterbalance the effect of the larger notch, the loading height is increased to 1·25 in., i.e., to a point near the tooth tip in the hypothetical gear tooth. The modifications are shown to reduce the stress concentration factor to that of the equivalent tooth and the stress pattern suggests that the specimen will break in a manner similar to the tooth. Specimen No. 5 (Figs. 10 and 11) is the scale model of the standard (square) Izod specimen loaded at points (1) 4·25 in. and (2) 1·0 in. from the notch. The corresponding photograph shows the high concentration of stress at the root of the notch and that the action of reducing the striking height caused stress interference from the point of loading. After consideration of all factors involved it was decided to adopt a specimen to design No. 4, shown in Fig. 9, for the simulated gear-tooth impact tests.

TABLE V.

Specimen Number.	Loading Height.	Load to Produce Two Fringes (Tension).	True Stress-Concentration Factor.
	In.	Lb.	
1 (Fig. 6) ..	1·0	63	1·34
2 (Fig. 7) ..	1·0	44	1·92
3 (Fig. 8) ..	1·0	43	1·97
4 (Fig. 9) ..	1·25	43	1·35
5 (Fig. 10) ..	4·25	6·2	3·10
6 (Fig. 11) ..	1·0	28	2·96

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[7] O. W. McMullan, "Endurance of Case-Hardened Gears." *Amer. Soc. for Metals*, Preprint No. 10 (1935).

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FILM OF MALLEABLE-IRON FOUNDRY.—A record of all the stages in the production of blackheart malleable-iron castings is shown in a film, entitled "Modern Malleable," made at the foundries of Hale and Hale (Tipton), Ltd., Dudley Port, Staffordshire. It is a 16-mm. sound film running for 32 minutes, and will be lent, without charge, to suitable institutions on application to the above address.

DEVELOPMENT OF CAR-FERRY AIR SERVICES.

A SIGNIFICANT development in post-war air transport has been the rapid growth of the cross-Channel ferry services for motor cars and bicycles, initiated in 1948 by a privately-owned charter company, Silver City Airways, Limited, 1, Great Cumberland-place, London, W.1. In the first year of operation, 170 vehicles were carried; last year the number had increased to 11,000, and this year, with the peak period for Continental travel still to come, 30,000 bookings have already been accepted.

Up to the present, ferry services have been operated between Lympne and Le Touquet (the shortest and most popular route) and between Southampton and Cherbourg by standard Bristol Freighter aircraft, and, more recently, by the "long-nosed" Mark 32 Bristol Superfreighters, introduced this summer between Gatwick and Le Touquet. Ultimately, the company hope to operate longer stages of 150 to 200 miles length, for which they propose to purchase double-decker Blackburn Universal freighters, with an all-up weight of 130,000 lb. Production of these aircraft is, however, in the early stages, and meanwhile the company are considering the possibilities of the Breguet 761 Deux Ponts transport aircraft, also a double deck machine, as a freighter on the Berlin-Hamburg route under contract to airlift. Since none of the existing British air-ferry terminal airports is adequate for such large aircraft as the Breguet Deux Ponts or the Blackburn Universal, and, moreover, Lympne airport is already working to capacity, Silver City Airways propose to construct their own airport, with two runways, 5,000 ft. and 4,200 ft. long, respectively, to be known as Ferryfield, and negotiations are now under way for the purchase of land in the Romney Marsh area.

The Breguet Deux Ponts aircraft delivered recently to the company is shown in the accompanying illustration, from which it may be seen that the lower part of the rear fuselage consists of four large panels which can be swung sideways by hydraulic jacks for freight loading. Mechanical hoists and overhead rails are provided within the fuselage to facilitate loading. It is powered by four 2,000-h.p. Pratt and Whitney R-2800 engines, fitted with reversible-pitch propellers, and has a retractable undercarriage. The aircraft, which has an all-up weight of some 50 tons and can carry a maximum payload of 30,000 lb., will accommodate six cars, three on each deck. At a cruising speed of 250 m.p.h., it has a range, with full payload, of about 1,250 miles.

FERODO BRAKE LININGS TO BE MADE IN BRAZIL.—Turner & Newall, Ltd., have acquired a controlling interest in a Brazilian brake lining company, Industria Nacional de Lonas Para Freio S.A., on behalf of one of their subsidiaries, Ferodo, Ltd., Chapel-en-le-Frith, England. The product of the Brazilian factory, which is situated at Sao Roque, in the State of Sao Paulo, is at present known by the trade name "Brakewell," but it is intended that, in due course, Ferodo linings will be made and marketed from that source.

THE BRITISH ASSOCIATION MEETING AT LIVERPOOL.

As previously announced in our columns, the annual meeting of the British Association for the Advancement of Science is being held this year in Liverpool, from September 2 to 9, under the presidency of Sir Edward Appleton, G.B.E., K.C.B., F.R.S. The inaugural meeting, at which the presidential address will be delivered and a number of honorary degrees will be conferred, is to be held in the Philharmonic Hall, Hope-street, on Wednesday evening, September 2. The title of the presidential address is "Science for its Own Sake." Sir Edward will also deliver a special address to student members, entitled "Finding Things Out with Radio and Rockets," on Thursday morning, September 3. Two evening discourses will be delivered this year, one on Friday, September 4, entitled "Fifty Years of Powered Flight," by Sir Ben Lockspeiser, K.C.B., F.R.S., and one on Monday, September 7, on the subject of "Mount Everest," by Mr. Eric Shipton. The address to students and the two evening discourses will be delivered in the Philharmonic Hall.

The 15 sections of the Association will begin their sessions on Thursday, September 3. Section G (Engineering) will meet in the Walker Engineering Laboratories and the first item on the programme will be the address by the president of the Section, the Rt. Hon. Lord Dudley Gordon, whose subject will be "Engineering in the Next 2000 Years." The remainder of the morning will be devoted to the subject of the utilisation of computing machines in engineering and industry. After an introduction by Professor F. C. Williams, papers by Mr. R. K. Livesley and Mr. G. C. Alway will be read and discussed. Two sessions, A and B, will be held on subsequent days of the meeting. On Friday, September 4, two papers will be taken in Session A, one by Dr. B. L. Goodlet on "The Outlook for Economic Nuclear Power," and the other by Dr. H. Heywood entitled "Solar Energy: Past, Present and Future Applications." In Session B, Mr. L. J. Murray will present a paper on "The Use of Electronic Methods in Telephone Switching," and Mr. F. C. McLean, M.B.E., will deal with "The Application of Colour to Television Broadcasting." On Monday, September 7, Session A will engage with Section J (Psychology) in a joint discussion on "Time and Motion Study." Papers will be read by Miss A. G. Shaw and Mr. Winston Rodgers; Mr. D. Wallis will open the discussion. In Session B papers by Mr. A. E. Margolis on "District Heating," and by Mr. A. T. Pickles, O.B.E., on "The Measurement of the Efficiency of Heating in Buildings," will be read and discussed. On the last day of the meeting, Tuesday, September 8, a joint paper by Mr. E. W. Colbeck, Dr. J. R. Tait and Mr. J. O. Ward on "The Design of Creep-Resisting Steels," will be taken in Session A, and this will be followed by a paper entitled "Titanium: A Metal of Engineering Importance?" by Major P. L. Teed.

In Session B, four short papers by young engineers and scientists will be dealt with in the following order: "The Isodynamometer," by Mr. J. Wright; "Combined Magnetisation of Magnetic Materials," by Dr. J. E. Parton and Dr. W. D. Sutherland; "Engineering Applications of Calorimetry, with Particular Reference to Magnetic Steels," by Mr. K. L. Morphew; and "Electro-Mechanical Analogies," by Mr. R. Yorke. A full programme of sectional visits and excursions to works and other places of technical interest has been arranged for the afternoons of each day of the meeting and there will be the usual general and sectional excursions on Saturday and Sunday, September 5 and 6. Among the social functions to be held during the meeting is a Conversazione for members of Section G, to be held in the University on Monday evening, September 7, by invitation of the Liverpool Engineering Society and the Engineering Faculty. Professor W. F. Cassie, King's College, Newcastle-upon-Tyne, 1, is Recorder of Section G.

ROYAL SANITARY INSTITUTE HEALTH CONGRESS.—The Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W.1, announces that the next health congress of the Institute will be held at Scarborough from Tuesday, April 27, to Friday, April 30, 1954.

NEW TYPES OF BOAT FOR THE ROYAL NAVY.

Among the boats to be carried in the Royal yacht, H.M.S. Britannia, now building at Clydebank, are two of new design which will come into general service in the Royal Navy. The Britannia will carry six boats, namely, the Royal barge, two 35-ft. admiral's barges, two 27-ft. jolly-boats, and a 32-ft. motor cutter.

The Royal barge will be the 40-ft. barge built by Messrs. Vosper, Limited, Portsmouth, shortly before the war, which is the smaller of the two existing Royal barges. The 32-ft. motor cutter is of the Admiralty's standard design, but with a special finish appropriate to the Royal yacht, and is under construction by Messrs. A. Rutherford and Company, Limited, of Birkenhead. The two new boats are the 35-ft. medium-speed admiral's barges and the 27-ft. jolly-boats, which have been designed by the Director of Naval Construction.

The 35-ft. barge has a length overall of 35 ft., a moulded beam of 9 ft., and a moulded depth of 5 ft. 7 in. In light condition, the weight is 5½ tons, and loaded, 7½ tons. The carrying capacity is about 30 persons. Twin Foden F.D. 4 Diesel engines, fitted with 2 : 1 reduction gear, and rated at 70 brake horse-power at 1,800 r.p.m., will give a speed of 12 knots. The barge is of round-bilge form and is not designed to achieve planing speed. The hull is designed to be as seaworthy as possible, with the minimum tendency to pounding in a head sea. Forward, the hull is relatively fine, but with a high freeboard to give good buoyancy. The principal accommodation is aft, as it was in the old type of steam picket-boat. The coxswain's position is amidships, immediately abaft and above the engine room.

The hull planking is of double-skin African mahogany, the inner skin being worked diagonally and the outer skin in fore and aft strakes. The framing is of bent timber, with closely-spaced transverse timbers laid outside longitudinal stringers. Riding timbers are worked at wide intervals inside the stringers to give added rigidity to the framing between the transverse bulkheads. The timbers and stringers are of Canada rock elm. The main transverse bulkheads are of plywood, bonded with phenol formaldehyde synthetic glue, and plywood is also used in the construction of the canopies. The hull construction, layout and design of the fittings are in accordance with the standard 35-ft. medium-speed motor boats to be carried by H.M. ships, but in those for the Royal yacht the finish and general decoration will be appropriate to this special service. The admiral's barges are being constructed by Messrs. McGruer and Company, Limited, Clynder, Dumbartonshire.

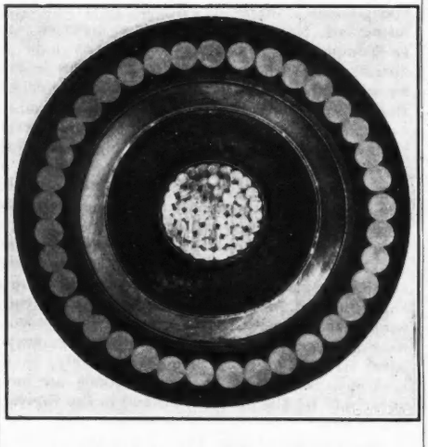
The new 27-ft. jolly-boat is an outcome of the requirement for motor sea-boats with good ability to work to windward under power. The main particulars are as follows : length between perpendiculars, 27 ft. ; moulded breadth, 7 ft. 7½ in., and depth, 3 ft. 7 in. ; weight, 3¼ tons in the light condition. A single Perkins P.4 Diesel engine is fitted, with a 2 : 1 reduction gear. It is rated at 35 brake horse-power at 1,200 r.p.m., giving a speed of 6 to 7 knots. The carrying capacity is 26 persons. In some respects, this jolly-boat resembles a lifeboat of the Royal National Life-boat Institution, the hull being fully buoyant when swamped.

The engine has a closed circulation system, with outside keel cooling of the circulating water. This enables the engine to be started up when the boat is in davits, which will ensure that the engine is running properly before the boat drops off the falls. The engine is enclosed in a watertight casing of aluminium alloy, and is capable of running when the boat is swamped. The slinging arrangements include Robinson's disengaging gear, which enables the boats to be released from the davit falls while suspended above the water. The jolly-boat for the Royal yacht will be a standard boat except in respect of finish. These boats are under construction by Messrs. R. A. Newman and Sons, Limited, of Hamworthy, Poole. Both of these new types of boat will be fitted with elaborate systems of buoyancy tanks, made of Fibreglass plastic material.

SUBMARINE POWER CABLES BETWEEN ENGLAND AND FRANCE.

As announced on page 31, *ante*, plans have been made for connecting the British 132-kV transmission system and the French 90-kV and 220-kV networks by a 132-kV cable circuit which will be laid under the English Channel between Dover and Calais. It was also announced that, to gain experience with the handling and jointing problems involved in this project, two half-mile lengths of single-core cable of British manufacture were to be laid near Dover by the cable ship Alert and were to be jointed at sea to a 300-yard length of French cable. A start on this work was made on Saturday, July 25, by hauling the first length of British cable from the Alert to a terminal hut a few hundred yards to the west of Shakespeare Cliff. It was then intended to join the second half-mile length of British cable to the first and to add the quarter mile length of French cable, a stop-end for which is being fabricated on board, to the two so as to enable tests at 300-kV direct-current to be carried out. The continuance of this operation was unfortunately delayed by bad weather and could not be resumed until the latter part of the week, when the second length of British cable was joined to the first. As we go to press, the French length is being joined to the second British length. It is hoped that the laying of the cable will be completed this week.

The two lengths of British cable which are being used in this experiment were manufactured by Messrs. W. T. Glover and Company, Limited, Trafford Park, Manchester, and are of that firm's high pressure gas-filled type.* As will be seen from the sectional view reproduced herewith the



core consists of 61 stranded copper conductors, each of which is 0·103 in. in diameter, so that the cross section is 0·5 sq. in. This core is screened with metallised paper and insulated with pre-impregnated paper strips which vary from 1·75 to 4 mils in thickness, so that the total dielectric thickness is 0·5 in. These strips were applied to the core in air and have an overall metallic screening. The maximum conductor stress is from 85 to 95 kV per centimetre, while that of the screen is from 40 to 45 kV per centimetre. The dielectric is covered by a sheath of lead alloy, which is designed to withstand vibration and to be capable of retaining nitrogen gas at a pressure of 200 lb. per square inch. It is reinforced mechanically with metallic tapes which are protected against corrosion by a layer of vulcanised rubber 0·1 in. thick. Over this protection comes a layer of impregnated fibrous material to serve as a bedding for the armouring, which in turn consists of high tensile aluminium alloy wires with a diameter of 0·25 in. This material has been chosen instead of the usual steel as being more resistant to salt water. It will also enable the magnetic losses in the armouring, which would otherwise occur owing to the single core cables, forming the finished circuit, having been laid from 500 to 1,000 yards apart, to be reduced. Finally, a serving is jute or hessian has been laid over the armouring. The finished diameter of the cable is about 3·5 in. and its weight from 35 to 40 lb. per yard. It has been designed so that the ultimate circuit should be capable of transmitting 200 MVA with a voltage between phases of 132 kV.

* For a full description of the design, construction and manufacture of the cable see "The High Pressure Gas-Filled Cable" by C. J. Beaver and E. L. Davey. Journal of the Institution of Electrical Engineers, Vol. 91, Part II, page 35 (1944).

THE INSTITUTE OF METALS.

As previously reported in our columns, the 45th annual autumn meeting of the Institute of Metals will be held at Southport, Lancashire, from Monday to Friday, September 21 to 25.

The meeting opens on the first day in the Town Hall, Lord-street, at 6.30 p.m., when Dr. Maurice Cook will deliver the 24th annual Autumn Lecture on "The New Metal Titanium."

On Tuesday, September 22, two concurrent technical sessions will be held in the Town Hall, from 9.45 a.m. until 12.30 p.m. The themes of session "A" will involve (*a*) "Stretcher-Strain Markings," and (*b*) "Priming Paints for Light Alloys," based on the following papers (*a*) "Occurrence of Stretcher-Strain Markings in an Aluminium-Magnesium Alloy," by Mr. R. Chadwick and Mr. W. H. L. Hooper ; "Influence of Composition on Incidence of Strain Markings in Aluminium Alloys," by Mr. W. H. L. Hooper ; "Stepped Stress-Strain Curve of Some Aluminium Alloys," by Mr. H. Krupnik and Dr. H. Ford ; "Discontinuous Flow and Strain-Ageing in a 6 Per Cent. Tin-Phosphor Bronze," by Dr. N. H. Polakowski ; "Yield-Point Phenomena and Stretcher-Strain Markings in Aluminium-Magnesium Alloys," by Dr. V. A. Phillips, Mr. A. J. Swain and Mr. R. Eborall ; "Methods of Measuring Surface Topography as Applied to Stretcher-Strain Markings on Metal Sheet," by Mr. W. H. L. Hooper and Dr. J. Holden ; and "Effect of Composition and Heat-Treatment on Yield-Point Phenomena in Aluminium Alloys," by Dr. V. A. Phillips. (*b*) "Priming Paints for Light Alloys," by Mr. J. G. Rigg and Mr. E. W. Skerrey. Session "B" will discuss "Oxidation and Sulphidation of Copper" and "Diffusions and the Kirkendall Effect."

In the afternoon, visits will be paid to the works of the Automatic Telephone and Electric Company, Limited; British Insulated Callender's Cables, Limited ; British Copper Refiners, Limited ; The English Electric Company, Limited ; D. Napier and Son, Limited ; The Manganese Bronze and Brass Company, Limited, and Pilkington Brothers, Limited.

Wednesday, September 23, will be devoted to visits to steel and non-ferrous metal works, etc. On Thursday, September 24, an informal discussion on "Damping Capacity" has been arranged for session "A." At session "B" discussions on "Structure of Nickel Alloys," based on three papers, by Mr. A. Taylor, Mr. R. W. Floyd and Mr. K. G. Hinton, and on "Properties of Chromium and Its Alloys," based on two papers, by Dr. A. H. Sully, Mr. E. A. Brandes, Mr. A. G. Provan, and Mr. K. W. Mitchell, will be held. Various visits to works have been arranged for the afternoon. Friday, September 25, will be devoted to a tour of North Wales.

The Late Mr. J. J. Fraser.—We regret to record the death, on July 17, of Mr. James Johnstone Fraser, managing director of Messrs. Honeywell-Brown, Ltd., makers of industrial recording instruments, of Perivale, Middlesex. Mr. Fraser, who was a native of Grantown-on-Spey, Morayshire, received his education in Edinburgh and spent some years in Nigeria before going to Canada in 1928 as manager of the Montreal office of the Minneapolis-Honeywell organisation, makers of industrial instruments. In 1936, when this American company decided to establish an associated British firm, Mr. Fraser was appointed managing director, the position which he held for the rest of his life. During the recent war, he concerned himself particularly with the production of navigational instruments for the Royal Air Force and the United States Army Air Force. Under his direction, the business expanded rapidly, until it now employs a personnel of some 450.

TEMPERATURE AND HUMIDITY CONTROL UNITS.

THE accompanying illustrations show two of three forms of an instrument for controlling convection and radiation temperatures and humidity, each form being based on the same type of actuating head. The principle of the actuating head—which is used in conjunction with a suitable amplifier and relay unit—depends on the expansion of the sensitive measuring element operating a pair of precision contacts. So light is the electrical loading on these contacts, 0·00005 amp., that a movement of two micro-inches (0·000002 in.) is sufficient to actuate the relay without any of the slight arcing to which many types of expansion-operated contacts are liable; risk of damage to the contact surface is therefore absent. The makers, P.A.M., Limited, Merrow, Guildford, Surrey, claim an accuracy of control to within $\pm 0{\cdot}2$ deg. C. for temperature and $\pm 0{\cdot}5$ per cent. for humidity. Each of the three types of the instrument is made in a range of sizes to suit a variety of conditions.

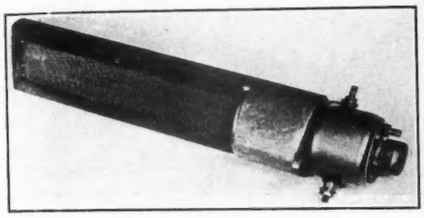


FIG. 1.

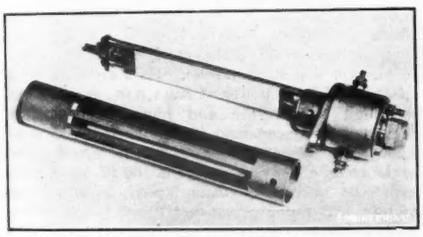


FIG. 2.

The basic instrument, the stem type, not illustrated, is suitable for a wide range of heating or refrigeration problems, and consists of the actuating head and a sensitive element made from a tube and rod of different metals. The rod, fixed only at the tail end of the tube and free to expand within the tube, acts directly on the contacts within the head. It is, of course, of paramount importance that both the tube and the rod shall be straight so that there is no impediment to expansion, but the stem-type instrument forms a general-purpose unit suitable for insertion in press platens, or for oven and space heating as well as for fluid baths.

The alternative to the stem type of temperature-control unit is the surface type, fitted with a radiation element, as shown in Fig. 1. This form of unit can be used where the stem type is impracticable, as, for example, for the temperature control of moving hot surfaces, such as rolls. The rod and tube unit is replaced by a flat strip of metallic foil suspended at its ends in a casing which exposes one side of the foil to the radiation from the hot body while protecting the foil from extraneous draughts and other radiations. The exposed surface is specially prepared to absorb readily the radiations from the hot body, and the temperature rise induced in the foil causes it to expand and close the contacts. Under suitable conditions, temperatures can be controlled to within $\pm 2\frac{1}{2}$ deg. C. with this type of instrument. Both the stem-type and the surface-type instruments can be used up to temperatures of 400 deg. C., but for higher temperatures up to 700 deg. C. it is necessary to employ the stem-type unit. A positive graduated finger adjustment is fitted, the range being chosen to meet the needs of the case.

The third type of instrument, for humidity control, which is shown in Fig. 2, is fitted with a sensitive element in which a short piece of hygroscopic material is the operative member. Mechanical protection of the sensitive material is provided by a slotted metal sheath. These units will work consistently at 95 per cent. relative humidity at 110 deg. F., and in conditions of dryness that approach 10 per cent. relative humidity. The units are also provided with an adjustment which has a range of about 40 per cent., and instruments can be supplied calibrated to operate over that range anywhere between 10 and 100 per cent. relative humidity.

In each instrument, when the contacts are closed, a very small low-voltage current passes through the circuit to the amplifier, where, amplified, it is used to excite a relay which is mounted in the amplifier chassis and carries the heating current. A suitable amplifier and relay unit, either for single or for multiple circuits, and contained within compact metal cases, is also made by P.A.M., Limited. It may be installed at the most convenient point in the heating circuit and connected to the control unit by a pair of conductors of any convenient length or type. A 200-volt to 250-volt alternating-current supply is required by the standard amplifier, which will take about six watts in addition to the intermittent heating current passing through the relay. A feature of this unit is that all the components, including the relay, are socket-mounted on the chassis so that testing and replacement can be done in a few minutes. These relays will switch currents up to 8 amperes at 250 volts. Normally, they are instantaneous in operation, but a delay, either fixed or variable, can be readily introduced.

THE OPERATING RANGE OF ELECTRONIC FLAME-FAILURE DEVICES.*

SINCE the operation of the majority of electronic flame-failure devices relies upon the electrical resistance of a flame, the North Thames Gas Board decided to determine the range over which such devices would operate. This was done by connecting resistances between the electrode and earth, and varying the value until the relay cut in. Two resistance ranges are necessary for this, one for the upper limit and one for the lower. Each range must be capable of a wide variation, since tests have shown that the upper limit may fall between 90 and 250 megohms and the lower between 80,000 and 500,000 ohms, according to the make of the control.

Numerous fixed resistances were obtained, having values between 10,000 ohms and 10 megohms. Ten 10-megohm resistances were coupled in series to give a fixed resistance of 100 megohms, and 15 of them were soldered to a multi-stud switch to enable the resistance to be varied in 10-megohm stages. The remainder were connected in series, with tapping points between each. For the determination of the upper limit, the megohm and 0·1 megohm resistances only were used. For the lower limit, the 10,000-ohm resistances were used, in conjunction with a Post Office box. Before carrying out the tests, the resistance insulators were cleaned with carbon tetrachloride and clean rag. This cleaning was repeated before each series of tests, to ensure that there was no leakage path across the resistances.

The method of obtaining the upper limit was to set the resistance to a value exceeding the upper limit, reducing it until the relay switch changed over; the reading was then taken. The value was increased until the relay cut out again; this value was also recorded. Two values for the upper limit were thus obtained, one being the maximum flame resistance at which the relay stayed in, the other being the maximum at which the control cut in. Similarly, for the lower range, the value of the resistance was increased until the relay cut in and was then reduced until it fell out. Both resistance values were recorded. By this method, two operating limits were obtainable for each device, one being the limits between which the relay would hold in, the other the limits between which the relay would automatically cut in. It was found that, once in operation, the electronic controls operated over a much wider range.

The effect of voltage variations was also determined and the results obtained on one device are given in Table I, herewith.

TABLE I.

Supply Voltage.	Upper Limit.		Lower Limit.	
	Energised, Megohms.	De-energised, Megohms.	Energised, Megohms.	De-energised, Megohms.
200	150	167·5	0·42	0·38
190	147·5	167·5	0·46	0·38
180	137·5	158·9	0·47	0·41
170	120	141	0·49	0·42

From these figures it became apparent that all controls should be tested at the same voltage in order to obtain comparative results. In the tests described, to eliminate difficulties experienced in obtaining the nominal single-phase alternating-current voltage, a value of 200 volts was selected. At this value, tests on three different types of control gave the results shown in Table II.

TABLE II.

Model.	Upper Limit.		Lower Limit.	
	Energised, Megohms.	De-energised, Megohms.	Energised, Megohms.	De-energised, Megohms.
1	224	254	0·35	0·32
2	100	170	0·09	0·05
3	149	161·8	0·38	0·35

The above figures show that the operating range of the electronic flame-failure devices tested is considerably greater than has been previously quoted. The list of devices tested is not yet complete, and it must be stressed that it is not possible, without considering all the operating conditions of the plant to which the electronic device is fitted, to decide on the advantages or disadvantages of any particular working range of electrical resistances. It is desirable for the lower operating limit to be high enough to ensure reasonable immunity from accidental operation by leakage resistance. Such an artificially-imposed leakage might be created, for instance, by the flame electrode touching damp brickwork, or by an operator being in a position to touch the electrode and hold it lightly.

The problem is eliminated entirely if a flame-failure device can be associated with a circuit which ensures that it is impossible to start up if there is a leak in existence. In the absence of such a circuit, however, it is not easy to reduce the lower operating limit without bringing about a corresponding reduction on the upper operating limit. Since these devices, in general, have to operate with a wide range of gases having different characteristics, the possible expense of making such equipment to reduce the lower operating limit only for one particular type of gas may not be justified, but as the resistance of the human body is of the order of 50,000 ohms, it may be desirable in any case to raise the lower operating limit to 0·5 megohm.

* From Report No. 515/52 of the Industrial Gas Development Committee of the Gas Council. Abridged.

EXHIBITION OF WELSH MANUFACTURED PRODUCTS.—The Welsh Industries Fair, which has been held annually since 1934, claims to be the only exhibition of its kind to be devoted solely to the display of products manufactured in Wales. The Fair is organised and managed by the National Industrial Development Council of Wales and Monmouthshire, 17, Windsor-place, Cardiff, which is a non-trading body composed of representatives of local authorities and industrial organisations in the area. This year's Fair is being held in the Pavilion, Sophia Gardens, Cardiff, from Wednesday, September 9, to Saturday, September 19, when a wide range of products will be displayed, representing the basic industries, manufacturing processes, and consumer goods such as concrete and building materials, radio and television apparatus, electrical appliances, and furniture. Among the exhibitors will be several firms who have recently established factories in Wales and Monmouthshire.

1,500-H.P. DIESEL-ELECTRIC LOCOMOTIVE FOR QUEENSLAND.

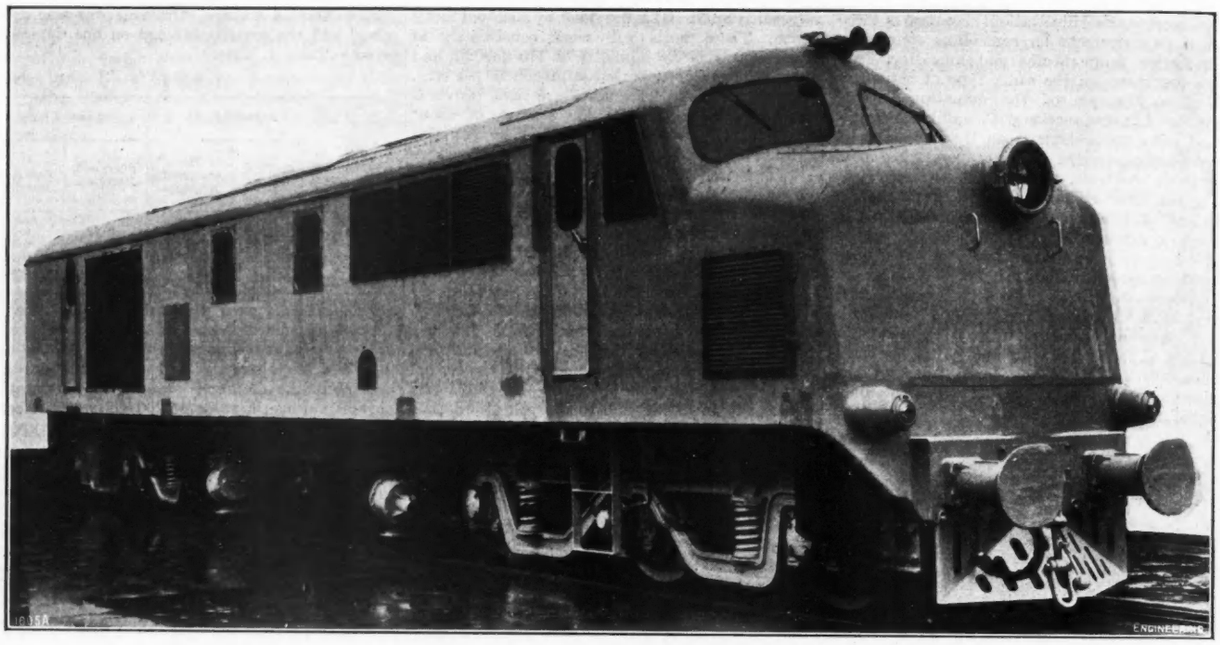


Fig. 1. General View of Locomotive.

1,500-H.P. DIESEL-ELECTRIC LOCOMOTIVES FOR THE QUEENSLAND RAILWAYS.

Ten 1,500-h.p. locomotives, which are now being built in this country for use on the 3 ft. 6 in. main line of the Queensland Government Railways, are of the Co-Co type. They are 54 ft. 10½ in. over the buffers, the total wheel-base being 45 ft. and the bogie wheel-base 12 ft. 6 in. The maximum width is 9 ft. 4 in. and the maximum height 12 ft. 8½ in. The weight in working order is 88 tons, which brings the axle loading down to 15 tons. This reduction has been rendered possible by careful attention to details in the design and has been obtained without any sacrifice of robustness. A general view of a completed locomotive is given in Fig. 1.

The underframe, for which the Vulcan Foundry, Limited, Newton-le-Willows, are responsible, as they are for the rest of the mechanical parts, is of fabricated construction and is braced by cross stretchers and gussets. Fabricated drag-boxes are provided for the buffers and drawgear, and the centre portion forms the 750-gallon fuel tank. The three-axle bogies, illustrated in Fig. 2, opposite, are of the swing bolster type and are also of fabricated construction, as are the bolsters which support the superstructure. The centres of these bolsters are provided with a floating gun-metal liner on the horizontal face, which is protected from dirt by an annular recess filled with hard grease. The bolsters themselves rest on nests of laminated springs, which are arranged transversely to the centre line of the locomotive. These springs are supported in turn on planks which are slung from the bogie frame by inclined links. Each bogie frame is carried on four further nests of coil springs, resting on equalising beams, these beams being supported on the axle boxes. Manganese-steel bearing pads are fitted at each corner of the swing bolsters and also on their vertical faces. The frames rest on corresponding pads on the underframe, which engage with manganese-steel liners on the stretchers. The lateral movement of the bolsters is limited by stops. The axle boxes are of the roller-bearing type and contain manganese-steel liners, which mate with others of the same material on the guides. The wheel centres are rolled-steel discs with shrunk-on tyres, secured by rings. The brake equipment is of the straight air and automatic type. There is also a hand brake.

The superstructure consists of rolled steel sections and angles, which are welded to the underframe so as to form an integral unit. The frame work is covered with steel sheet and side panels, which are also attached by welding the joints, being ground flush to provide a smooth exterior finish. The superstructure is divided into a nose compartment, cab, engine compartment and rear end compartment. The nose compartment houses an electrically-driven blower from which cooling air is supplied to the three motors on the leading bogie, as well as certain brake fittings. The bulkheads and roof of the cab, which is planned to provide maximum comfort for the driver and his assistant, are insulated against both sound and heat. Ventilation is by an adjustable duct which is connected to the traction-motor cooling circuit. The driving ammeter and speedometer, as well as the brake gauges, are in enclosed boxes which are directly illuminated for night driving. The speedometer equipment includes recording apparatus.

The engine compartment contains the engine and generator, the control cubicle, two battery boxes and a fuel supply unit. As can be seen in Fig. 3, which shows a locomotive under construction, its roof consists of removable sections. There is a hinged door over the cylinder heads; and maintenance is further facilitated by a servicing hatch on each side. The radiator compartment, illustrated in Fig. 4, is separated from the engine compartment by bulkheads and contains radiators of unit construction, with oil and water cooling elements. The water sections are thermostatically controlled so that the elements can be by-passed while the engine is being warmed up. Ventilating air is drawn into the engine compartment through louvres and filters by a 5-ft. diameter fan in the roof, as can be seen in Fig. 3. This fan is driven from the engine through gearing, flexible couplings and a friction clutch. Combustion air is also drawn in through filters, which are connected by trunking to the turbo chargers. In the end compartment of the locomotive is a compressor with a capacity of 150 cub. ft. per minute, driven from the engine through the same gearbox as the radiator fan. This compartment also contains a blower for the three traction motors on the trailing bogie, a 40-gallon water tank and hand pump, and two resistance frames.

The Diesel engine, supplied by the English Electric Company, Limited, is of the pressure charged four-stroke V type and has 12 cylinders, 10 in. bore and 12 in. stroke. Its normal rating is 1,500 brake horse-power at 850 r.p.m., but to meet the high temperature and humidity conditions prevalent in Queensland it has been de-rated to 1,290 brake horse-power at the same speed. The brake mean effective pressure is 106 lb. per square inch, the maximum piston speed 1,700 ft. per minute, and the average fuel consumption at full load, 75 per cent. and 50 cent. loads, 0·389, 0·378 and 0·399 lb. per brake horse-power, respectively. The engine is of the English Electric Company's naturally-aspirated in-line type, but is fitted with two Napier turbo-chargers. Each of these chargers serves six cylinders and has an automatic lubricating system which is entirely independent of that of the main engine. The engine exhaust manifolds are between the cylinder banks. Fuel is supplied by the electrically-driven pump illustrated in Fig. 5, the output of which is regulated by a governor, driven from one of the camshafts at the flywheel end of the engine and actuated by a servo mechanism operated by the lubricating oil system. Lubricating oil is supplied by two pumps which are driven from the crankshaft. One of these draws oil from the engine sump and circulates it through a radiator, and the second draws it through the radiator and delivers it through fillers to the main crankshaft bearings and thence to the big end and gudgeon pin bearings. The camshaft bearings and pump drives are also force-lubricated, and the valve gear is supplied at a reduced pressure from the main system. The engine is started by motoring the main generator from a 48-cell 185-ampere-hour lead-acid battery. A trip is provided which automatically shuts the engine down should its speed rise above a pre-determined maximum. Automatic shut-down also occurs if the lubricating-oil pressure falls below a pre-determined value or the cooling water below a certain level. These conditions are also indicated by warning lamps in the cab, where other lamps show failure of a blower motor or the occurrence of wheel slip.

The main generator is bolted to an extension at the flywheel end of the bedplate and is direct-coupled to the crankshaft. It is of the single-bearing self-ventilated type, with both separately-excited and

1,500-H.P. DIESEL-ELECTRIC LOCOMOTIVE FOR QUEENSLAND.

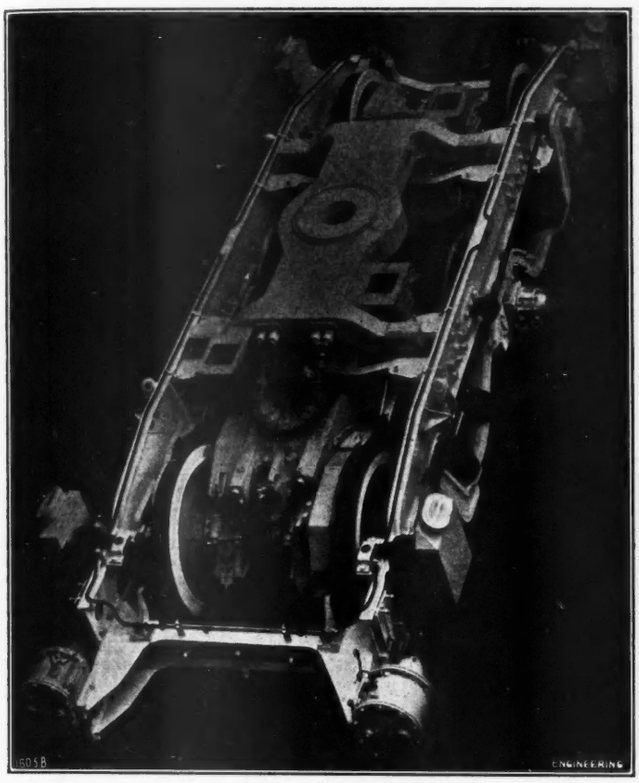


FIG. 2. BOGIE AND TRACTION MOTORS.

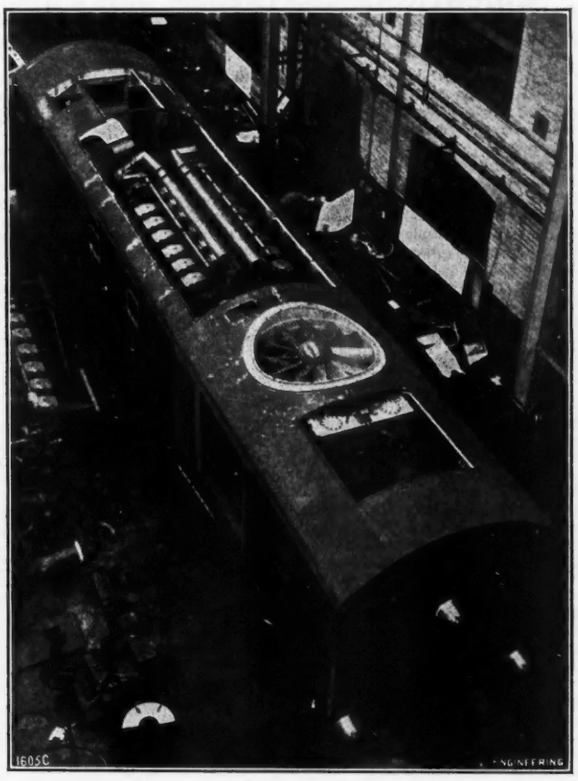


FIG. 3. LOCOMOTIVE UNDER CONSTRUCTION.

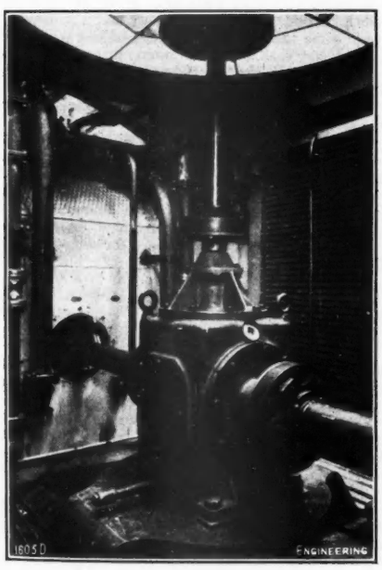


FIG. 4. RADIATOR COMPARTMENT.

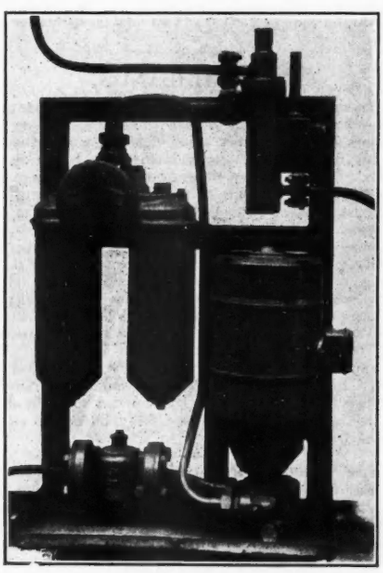


FIG. 5. FUEL SUPPLY UNIT.

self-excited field windings. There is also a third winding for use when the generator is motored to start the engine. A shunt-wound constant-voltage auxiliary generator is overhung from the main generator and is used to supply the control circuits, the separately-excited field of the main generator, the blower motors, the locomotive lighting, and for battery charging. The main generator supplies current to the six nose-suspended series-wound traction motors, which drive the axles through single-reduction gearing. They are connected in three parallel groups of two, in series. The electro-pneumatic and electro-magnetic contactors, reverser and associated relays are mounted in a dustproof cubicle in the engine compartment.

Operation is effected from a master controller which incorporates a main control handle, reverser and master switch. The first of these is used to regulate the output of the engine-generator unit and has ten notches, corresponding to the outputs obtainable by running the engine at speeds of 450, 620 and 850 r.p.m., and varying the main excitation. The master switch is used to start and stop the engine. The engine is started by first placing the master switch in the "start" position and then in the "engine only" position, so that it can be run at the two lower speeds without exciting the main field. To move the locomotive, the master switch is placed in the "on" position with the reverser handle set for the appropriate direction of travel, and the controller on the first running notch, so that the electro-pneumatic reverser is set in the selected position and the motors are connected to the generator through contactors. Further movement of the control handle increases the field of the generator and the speed of the engine. On the tenth notch the excitation is adjusted automatically so that its output corresponds to the available engine power, irrespective of the locomotive speed. When the automatic regulator reaches its position of maximum travel, the fields of the traction motors are weakened.

These locomotives, which have a starting tractive effort of 49,000 lb. at 25 per cent. adhesion and a continuous tractive effort of 30,000 lb. at 12·4 m.p.h., are to be used to operate express mail trains on the Brisbane-Cairns, Brisbane-Roma and Rockhampton-Emerald routes at a maximum speed of 45 m.p.h. On the first of these, the ruling gradient is 1 in 75, with shorter sections of up to 3 miles at 1 in 50. The distance between terminals is 1,043 miles, and it will be possible to reduce the journey time of a 420-ton train from 44 to 31 hours. The Brisbane-Roma line is also heavily graded, the most difficult section being one of 16 miles with an average gradient of 1 in 70 and including considerable lengths at 1 in 50, with curves of radii as little as 5 chains.

SAFETY GATES IN PIT SHAFTS.—To improve safety at the pit bottom, safety gates have been installed at the bottom of the shaft at Ledstone Luck Colliery, Yorkshire. The gates, working in pairs on both sides of the shaft, are operated by the moving cage during the last three feet of its travel so that the cage is completely fenced off until it comes to rest.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

Historic Turbines for Glasgow Museum.—On Thursday, July 30, two of the turbines of the Clyde steamer King Edward, the first turbine passenger steamer in the world, were delivered for permanent preservation to the Glasgow Museum, where they will be on exhibition in the Clyde Room of the Technology Department. The exhibit consists of one high-pressure turbine and one low-pressure turbine, weighing 5 tons and 8 tons, respectively, which have been overhauled and prepared for display by the original builders of the ship, Messrs. William Denny and Brothers, Ltd., Dumbarton. The turbines were constructed more than 50 years ago by the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne, and have been presented to the Museum by the British Transport Commission. They were received on behalf of the Museum by the Director, Dr. Stuart M. K. Henderson.

Prestressed-Concrete Water Tank.—Mr. Guy D. Allison, chief engineer of Preload (Great Britain), Ltd., London, who are constructing a 2,000,000-gallon pre-stressed concrete tank at Hollowhouse for Paisley Town Council, states that the adoption of prestressed concrete will result in savings in cement of about 25 per cent. and 75 per cent. in steel. The tank, said to be the largest of its kind in Britain, will take about nine months to complete. Another similar tank is to be built in due course. They form part of a scheme costing 400,000*l.* for the extension of the water undertaking.

Douglas Colliery, Lanarkshire.—The opportunity was taken at Douglas Colliery, Lanarkshire, during the Fair holidays, when the 1,000 employees were on holiday, to test conditions in a section of the pit which was sealed off before the war because of an outbreak of fire. Samples of air behind the first stoppings were taken, and analysed by a chemist operating from a mobile laboratory. No definite change in the general state of the atmosphere was found, it was stated, to warrant any likelihood for the reopening of the section in the immediate future.

CLEVELAND AND THE NORTHERN COUNTIES.

Industrial Scheme for Seaham Rejected.—The National Coal Board have informed Seaham Urban District Council that there is no prospect of extending the local brickworks, or of setting up works for the manufacture of mining supplies. The Council, who had suggested these measures to provide work for local disabled people, will now take up the matter with the Board of Trade.

Proposed Dry Dock at South Shields.—It is understood that Brigham and Cowan, Ltd., the South Shields shiprepairing firm, have not yet reached a decision whether or not to proceed with their plan for a new dry dock. When the scheme was first mooted soon after the war, it was estimated that it would cost 200,000*l.*

Shipbuilding at Berwick-on-Tweed.—William Weatherhead & Sons have sold their small shipyard at Berwick to the Fairmile Construction Co., Cobham, Surrey, who will operate it under the style of the Berwick Shipbuilding and Engineering Co. The yard was reopened about four years ago.

Coke Works at Monkton, Durham.—Opposition to the National Coal Board's plans to extend the Monkton Coke Works, Co. Durham, has been withdrawn. Local authorities who feared that the extensions would increase fumes from the works have been informed that the extensions will incorporate precautions to remove most of the causes for complaint.

Shipbuilding Order for the Tyne.—John Readhead & Sons, South Shields, have received a repeat order for a cargo ship of 8,500 tons for the Bristol City Line. The first order was announced over two years ago. The ships will trade between Bristol and the eastern seaboard of the United States and Canada.

Noble and Lund, Ltd.—Plans have been approved for extensions to the machine and fitting shops of Noble and Lund, Ltd., tool makers, Felling-on-Tyne.

Proposed New Bridge at South Bank-on-Tees.—Eston Highways, Drainage and Planning Committee are supporting representations by Smith's Dock Co. Ltd., for the construction of a new bridge over the Darlington-Saltburn railway near Lorne Terrace, South Bank. The firm state that, owing to the absence of a bridge, they are having to bring much of their heavy equipment in small component parts to their works. This is causing an increase in building costs. The committee decided to give the firm's representations to the Ministry of Transport their "whole-hearted support."

LANCASHIRE AND SOUTH YORKSHIRE.

Sheffield Development.—At an inquiry into Sheffield's 20-year development plan, it was contended on behalf of Derbyshire County Council that factories should follow the people into areas around Sheffield, so that those who were obliged to live beyond the boundary should not have to travel long distances daily to work. It was stated that the County Council were willing and anxious to co-operate in providing accommodation for "overspill" population and in making land available for industrial purposes. It was intended to provide sites for industry in addition to the sites at Frecheville, Hackenthorpe and Gleadless; and there was a proposal that Eckington, Mosborough and Killamarsh should be extended to receive an estimated 19,000 people from Sheffield.

Private Ownership in Steel.—Mr. G. Wilton Lee, chairman and managing director of Arthur Lee & Sons, Ltd., Sheffield, manufacturers of cold-rolled steel strip, bright-drawn bars and wire, has stated that it is the policy of the Board to re-acquire the business, which was founded by his grandfather, if the terms and conditions are reasonable.

The International Harvester Co., Ltd.—The Doncaster factory of the International Harvester Co., Ltd., is to be extended to cope with expanding demand on home and export account for the firm's agricultural machinery, which, in the present year, has been dispatched to 46 countries. There are vacancies at present for 60 more men, skilled and semi-skilled, and the extensions, when completed, should provide employment for a further 600.

Employment at Scunthorpe.—The manager of the Scunthorpe Employment Exchange states that 400 more men are still needed in the iron and steel works there. The main difficulty is lack of housing accommodation, the hostels being full and private lodgings scarce. It is estimated that, next January, an additional 200 men will be needed for the local steelworks, on the completion of two new blast-furnaces.

THE MIDLANDS.

Reconstruction in the Shropshire Coalfield.—The Shropshire coalfield is a small one, and in the once-important colliery areas of Madeley and Oakengates there are only two producing units left in operation. Boreholes have shown, however, that there are sufficient reserves of coal to justify modernising the existing pits, and the West Midlands Division of the National Coal Board have schemes in hand which will increase the output considerably. At Kemberton Colliery, Madeley, a level locomotive road, three miles long, is being driven in a north-easterly direction to give access to recently proved reserves. The existing electric winder is being replaced by a larger one, which will raise 800 tons of coal a day on a single shift instead of 700 tons a day on two shifts, as at present. The output is expected to rise eventually to 1,600 tons a day. Similar arrangements are in hand for Granville Colliery, Oakengates, where Diesel underground haulage is being introduced, and the daily output is to be trebled.

The Daimler Motor Works, Coventry.—The works of the Daimler Co., Ltd., at Coventry was the most severely damaged of all the motor-car factories in the Midlands during the war, over 700,000 sq. ft. of floor space being lost by enemy action. The work of concentrating the scattered production units has now been completed, and the company have a factory at Radford, Coventry, which not only replaces the facilities lost during the war, but provides a far greater production capacity than before. A new foundry has been built, which, as in the case of the previous foundry, is capable of producing castings in non-ferrous metals, iron and steel—an unusual combination in motor-vehicle works. A new assembly shop, 740 ft. long, has also been completed and is now in use.

The Shropshire Landslip.—A report on the investigation into the slow landslip at Jackfield, Broseley, Shropshire, has now been presented by the Shropshire County Planning Committee to the County Council. For some years, a large area of land has been moving slowly towards the River Severn, and during the last 18 months the movement has become more pronounced. The landslip has caused damage to houses, and several buildings have been destroyed or rendered unsafe. The opinion of the experts is that the river itself is the cause of the landslip, and that past mining activities, which have been blamed in some quarters, are not responsible. The river is young, geologically speaking, the gorge through which it passes at Jackfield having been formed in glacial times. There are no alluvial flats, and the valley sides are unstable. As a result, erosion of the banks by the river is causing the land to slide. The report states that it might be possible to halt the landslip, but that the cost of doing so would be high, and it is recommended that the natural process should be allowed to continue.

The Employment Position.—The recent improvement in trade in the motor industry is largely, though not entirely, responsible for a reduction in unemployment in the West Midlands. The percentage of the working population of the area now unemployed is now only 1·0, compared with the national figure of 1·4 per cent. In spite of this improvement, however, there are still some parts of the district where the position is not so satisfactory. Producers of steel sheet for electric-motor laminations are finding conditions unsettled at present, and some of the steel re-rolling mills in Staffordshire and Shropshire are still compelled to lose one working shift a week because of a shortage of suitable steel billets.

SOUTH-WEST ENGLAND AND SOUTH WALES.

Bristol Channel Overseas Trade.—Trade passing through the South Wales ports up to July 12 this year was 390,119 tons below the level reached a year ago. Imports were heavier at 5,430,127 tons, compared with 5,190,678 tons; but exports declined from 6,895,276 to 6,265,708 tons. Exports of coal and coke to foreign destinations rose from 1,914,977 tons to 2,063,542 tons. Tin-plate deliveries abroad were little changed at 132,201 tons, against 136,077 tons a year ago; but exports of iron and steel goods rose from 130,781 to 154,981 tons.

The Price of Steel Products.—Following upon representations made by Sir Percy Thomas, chairman of the Welsh Board for Industry, to the Production Advisory Council for Industry, the Ministry of Supply has agreed to a reduction of 7*s.* 6*d.* per ton in the maximum price of heavy steel products delivered to South Wales, as and from July 27. Protests were made some time ago at meetings of the Welsh Board for Industry that, under the zoning price scheme, South Wales industries were placed at a disadvantage.

Coal Imports.—The prospects of importing, through South Wales ports, any of the coal which the National Coal Board are to buy from Western European countries to help to avoid a fuel crisis next winter, appear to be slight. So far, it is reported on the Welsh steam coal market, the Coal Board have made arrangements to buy 300,000 to 500,000 tons from France, and more from Belgium. Representations have been made in Parliament and to the Coal Board for some of the coal to be brought into South Wales ports; but the Board have replied that it will be brought into the Thames and to the South England ports nearest to the source of supply and the centres where the coal will be used.

Proposed Large Dry Dock at Cardiff.—At the annual general meeting of Mountstuart Dry Docks, Ltd., who own several large dry docks in Bristol Channel ports, the chairman, Sir Llewellyn T. G. Soulsby, J.P., M.Inst.N.A., referred to the campaign for the construction at Cardiff of a dry dock capable of accommodating the large oil tankers now being built, and expressed the opinion that Cardiff would not lose anything during the next few years for want of such facilities. The Mountstuart Company, he said, had given much consideration to the question, bearing in mind the number of new ships of such large size likely to be in service in that time; the likelihood of tankers of very large size predominating in the future, to the exclusion of smaller tankers; and the question whether the general trade of Cardiff would increase to an extent that would justify the expenditure of 1,250,000*l.* on such a dock.

Newcomen Anniversary Ceremony.—The annua commemoration of the death of Thomas Newcomen, the "father of the steam engine," who died 224 years ago in London, will take place at Dartmouth, Devon, on Saturday and Sunday, August 15 and 16, under the auspices of the Dartmouth Newcomen Association. Particulars may be obtained from the joint honorary secretaries of the Association, namely, Mr. C. B. Milne, B.A., 12, Fairfax-place, Dartmouth, and Mr. Percy Russell, F.S.A., Waterside, South Town, Dartmouth.

CONTRACTS.

Orders recently placed by the North Eastern Region of British Railways include the erection of mess-room accommodation at Oakwellgate, Gateshead-on-Tyne, County Durham, with BEWLEY AND SCOTT, LTD., Back Taylor-terrace, Dunston, Gateshead-on-Tyne; the erection of a building to house the chain annealing furnace at Stooperdale Works, Darlington, County Durham, with E. DAVIS (FIXERS), LTD., 20A, William-street, York; and the modernisation of the goods depot and the erection of a covered area for the forwarding line at Darlington, with E. DAVIS (FIXERS), LTD.

THE AUSTIN MOTOR CO., LTD., Longbridge Works, Northfield, Birmingham, 31, announce that they are to supply nearly 600 commercial vehicles for use in the rehabilitation of South Korea, and that the delivery of them to the United Nations Korean Reconstruction Agency is now beginning. Among the vehicles included in the order are long-wheelbase trucks, tipping trucks, four-wheel-drive trucks and breakdown vehicles.

THE ENGLISH ELECTRIC CO., LTD., Queen's House, Kingsway, London, W.C.2, have obtained the contract for the completion of the new 11-kV alternating-current electricity distribution scheme at Zanzibar, East Africa. ENFIELD CABLES LTD., Victoria House, Southampton-row, London, W.C.1, have been appointed sub-contractors and are supplying and placing in position the underground cables and overhead lines, including concrete poles and equipment. The 11-kV 660-volt underground cables being used on the contract are of the paper-insulated, lead-sheathed, double-wire-armoured variety. They have been specially protected against the effects of alkaline soil and from attack by white ants.

MARCONI'S WIRELESS TELEGRAPH CO., LTD., Chelmsford, Essex, have received an order through their associated firm, the CANADIAN MARCONI CO., for the complete transmitter, studio, and mobile-broadcasting equipment to be used by the Canadian Broadcasting Corporation in connection with the erection of their fourth television transmitting station at Vancouver, at which transmissions are expected to commence at the end of the year. The station will have a 5-kW vision transmitter, a 3-kW sound transmitter, combining unit, and ancillary equipment. One studio will be built at Vancouver and this will be provided with three camera channels, monitoring and production equipment, and a master control unit. The system will be operated on the North American standard of 525 lines 60 cycles.

VIENNA SPRING TRADE FAIR.—The 34th International Spring Fair will be held at Vienna from Sunday, March 14, to Sunday, March 21, 1954, inclusive. The British-Austrian Chamber of Commerce, 29, Dorset-square, London, N.W.1, act as representatives for the Fair in the United Kingdom.

FINISHING SMALL COMPONENTS.—Roto-Finish, Ltd., 39, Park-street, London, W.1, are now making a "Midget" version of their precision barrel finishing machine wherein small components can be de-scaled, de-burred, and polished under production conditions. The larger medium-sized machine in the same series was illustrated and described in our report of the British Industries Fair at Birmingham for this year, in ENGINEERING, vol. 175 (1953), page 547.

BRITISH RADIO COMPONENT EXHIBITION IN SWEDEN.—An exhibition of British radio and electronic components, valves and test gear is to be held in Stockholm from Friday, September 25, to Tuesday, September 29, 1953. It is being organised by the Radio and Electronic Component Manufacturers' Federation, and will be held at the Kungshallen, Kungsgatan, where a similar exhibition was held in 1948. Hours of opening will be 10 a.m. to 6.30 p.m. The Exhibition will not be open on Sunday. Between 20 and 30 leading British firms will exhibit.

TENTH INTERNATIONAL PRINTING, MACHINERY AND ALLIED TRADES EXHIBITION.—Arrangements have been made for the 10th International Printing, Machinery and Allied Trades Exhibition to be held at Olympia, London, W.14, from Tuesday, July 5, to Saturday, July 16, 1955. The exhibition will occupy an area of about 250,000 sq. ft., and will be the first post-war exhibition in the United Kingdom to be devoted to the printing trades. It is being promoted by the Association of British Manufacturers of Printers' Machinery (Proprietary), Ltd., Clifford's Inn, London, E.C.4, and is being organised by F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2, to whom all communications should be sent. The first exhibition of the series took place in 1904.

TRADE PUBLICATIONS.

Plumbago Crucibles and Accessories.—A catalogue giving detailed particulars of their Salamander plumbago crucibles and accessories for metal melting has been issued by the Morgan Crucible Co. Ltd., Battersea Church-road, London, S.W.11. The descriptive matter and data are given in English, French, German and Spanish.

Hot Bloom and Slab Shears.—Davy and United Engineering Co., Ltd., Park Iron Works, Sheffield, 4, have sent us a copy of their publication No. 111, dealing with hot bloom and slab shears and shears for billets, bars and plate. Recent installations of downcutting and upcutting shears, cropping shears, flying billet shears, guillotine plate shears, rotary side-trimming shears and other machines are described and illustrated.

Industrial Ceramics.—An illustrated pamphlet describing their industrial stoneware; porous ceramic filter tubes, discs and tiles; porcelain laboratory apparatus; electrical insulators, and sanitary ware, has been prepared and issued by Doulton & Co., Ltd., Doulton House, Albert-embankment, London, S.E.1.

Aluminium-Alloy Sheet Products.—The Northern Aluminium Co., Ltd., Banbury, Oxfordshire, have sent us a copy of their publication "Noral Sheet Products—Part I." This gives the standard sizes, the manufacturing limits and the manufacturing tolerances of the aluminium-alloy flat sheet, coiled sheet and plate produced by the company.

Laboratory Equipment.—Illustrated descriptions of Raymond laboratory equipment, including grinding and pulverising mills and separators for pulverised products, are given in a catalogue issued by International Combustion, Ltd., 19, Woburn-place, London, W.C.1.

Wrought Aluminium Alloys.—The compositions, physical and mechanical properties and main applications of the "Kynal" and "Kynalcore" range of wrought aluminium alloys are given in detail in a publication issued by Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1.

Pressure Vessels.—Messrs. G. A. Harvey & Co. (London), Ltd., Greenwich Metal Works, Woolwich-road, London, S.E.7, have sent us a copy of their list No. 880, entitled "Fabrication and Welding." This deals with the machines and methods employed for the production of pressure vessels from heavy steel plate.

Hard Wear-Resistant Facing Alloys.—A new edition of the booklet, "Hardfacing with Deloro Stellite," has been issued by Deloro Stellite, Ltd., Highlands-road, Shirley, Birmingham. Much information has been added to enable alloy and special steels to be satisfactorily faced with Stellite. Full details are given of the pre-heat and subsequent cooling necessary for the deposition of the hard alloy, by the oxy-acetylene and arc process, on the British Standard En series of steels.

Brazing Processes.—Revised editions of two leaflets, the one dealing with "Tool-Tipping with Sifbronze," and the other with "Brazing and Low-Temperature Welding of Aluminium by 'Process 36'," have been issued by Suffolk Iron Foundry (1920), Ltd., Sifbronze Works, Stowmarket, Suffolk.

Electric Heat-Treatment Furnaces.—A publication received from Wild-Barfield Electric Furnaces, Ltd., Elecfurn Works, Watford By-Pass, Watford, Hertfordshire, describes the firm's vertical electric furnaces fitted with solid rod or tubular "hairpin" heating elements for metal-hardening, annealing, normalising and carburising operations.

Creep and Scale-Resistant Copper Alloy.—N. C. Ashton, Ltd., St. Andrew's-road, Huddersfield, have prepared and issued a folder describing their Nargias "B" creep and scale-resisting copper-aluminium alloy designed for heat-exchanger tubes to withstand the stresses and the scaling produced in gas-turbine atmospheres at temperatures in the range 0-600 deg. C.

Time Recorders.—We have received a number of leaflets from General Signal & Time Systems, Ltd., 73, Great Peter-street, London, S.W.1, describing their clocks and time-recording machines.

Automatic Clutch and Coupling.—An illustrated booklet entitled "Shockless Power Transmission," sent to us by Compression Ignition, Ltd., The Green, Twickenham, Middlesex, describes their "Twiflex" automatic-clutch and flexible-coupling which are made for a range of horse-powers from one-tenth to 3,000.

Pressure-Operated Valve Regulator.—The Fisher Governor Co., Ltd., Century Works, Lewisham, London, S.E.13, have sent us a pamphlet containing particulars of their "Wizard" pressure controllers for reducing valves, which are designed to control the vacuum or pressure of all fluids and gases up to 5,000 lb. per square inch.

Metal-Working Machinery.—A new catalogue of ferrous and non-ferrous metal-working plant, connected primarily with the operations of bending, straightening, shearing and metal forming, has been published by Joshua Bigwood & Sons, Ltd., Wolverhampton. This catalogue supersedes one issued five years ago.

PERSONAL.

SIR SYDNEY CAMM, C.B.E., a director and chief designer of Hawker Aircraft, Ltd., has been elected President of the Royal Aeronautical Society, 4, Hamilton-place, London, W.1, and will be installed at the annual general meeting of the Society on May 6, 1954.

THE EARL OF FEVERSHAM, D.S.O., D.L., J.P., has accepted the invitation of the Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W.1, to become President of the Institute's Health Congress in 1954.

MR. W. J. RICHARDS, C.B.E., B.Sc., chief superintendent of the Telecommunications Research Establishment, Malvern, has been appointed Director of the Radar Research Establishment. The two electronic experimental stations of the Ministry of Supply, at Malvern, are to be amalgamated on September 1 and will then be known as the Radar Research Establishment.

MR. C. W. A. PRIEST, B.Sc. (Eng.), A.M.I.Mech.E., M.I.E.E., generation engineer (construction) of the Southern Division of the British Electricity Authority, has been appointed chief generation engineer (construction) of the South Wales Division, in succession to MR. T. H. WOOD, M.I.Mech.E., A.M.I.E.E., who recently retired.

MR. H. ECKERSLEY, M.I.Mech.E., M.I.Prod.E., general manager of the Wimet division of Wickman Ltd., Coventry, and MR. W. V. Hodgson, M.I.Prod.E., general manager of the firm's machine-tool division, have been made directors of the company, with effect from July 15. A local board has been established, to which MR. R. J. DIXON, chief engineer, MR. T. W. HAYES, export sales manager, and MR. S. W. PERKINS, machine tool sales manager, have been appointed as special directors.

SIR ALAN RAE SMITH, K.B.E., F.C.A., and SIR HAROLD BARTON, F.C.A., have been re-appointed by Mr. Alan Lennox-Boyd, the Minister of Transport, as auditors for the accounts of the British Transport Commission.

MR. E. W. SPALDING, M.C., Wh.Ex., A.M.I.Mech.E., has retired from Ruston and Hornsby, Ltd., Lincoln, after more than 50 years' service with the company. He was appointed commercial manager in 1944 and a director in 1947. His successor as commercial after more than 50 years' service with the company. manager is MR. C. T. ALDERSON, J.P., M.A. (Cantab.), who has been contracts manager since 1945.

MR. JOHN P. TAYLOR, A.Inst.N.A., editor of the *Shipbuilding and Shipping Record*, 33, Tothill-street, London, S.W.1, since its foundation some 40 years ago, has retired, and has been succeeded by MR. DAVID AICKEN, B.Sc., A.M.Inst.N.A.

MR. E. S. WADDINGTON, F.S.E., M.Inst.W., A.I.E.E., of the industrial products department of Philips Electrical, Ltd., Century House, Shaftesbury-avenue, London, W.C.2, has been re-elected to the Council of the Institute of Welding.

MR. S. A. ROBERTS, A.M.I.Mech.E., has been appointed general manager of the group of companies controlled by B.S.A. Tools Ltd., Mackadown-lane, Marston Green, Birmingham.

THE BRITISH STANDARDS INSTITUTION state that their removal to 2, Park-street, London, W.1, which will begin on August 10, is expected to be completed by August 17. The new telephone number of the Institution will be MAYfair 9000.

STRUCTURAL AND MECHANICAL DEVELOPMENT ENGINEERS LTD., 2, Buckingham-avenue, Slough, Buckinghamshire, announce that the name of the company has been changed to S.M.D. ENGINEERS LTD., and that their telegraphic address has been altered to "Alframe, Slough." This firm is responsible for the construction work of the Almin group, of which Almin Ltd., are the parent company.

The telephone numbers of the ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS, 166, Piccadilly, London, W.1, have been changed to HYDe Park 4126/7 and HYDe Park 1557/8. These alterations also affect a number of affiliated organisations operated from the same address, including the BRITISH COLOUR MAKERS' ASSOCIATION and the INDUSTRIAL PEST CONTROL ASSOCIATION.

THE TYNE PLYWOOD WORKS, LTD., Willington Quay, North Shields, have changed their name to TYNE TIMBER AND VENEERS, LTD. The firm will remain under the same management as before, with a board of directors composed of Mr. M. Rosenberg, Mr. H. Ross and Mr. E. H. Silverstone.

THE MIDLAND BRIGHT DRAWN STEEL AND ENGINEERING CO., LTD., Brickhouse Lane, West Bromwich, Staffordshire, have purchased the share capital of E. A. Godrich & Son, Ltd., Wharf-street, Aston, Birmingham, 6. The firm of A. E. Godrich & Son, Ltd., which produce steel wire, was founded in 1887.

THE MANUFACTURE OF SEAMLESS TUBES.

ACCLES AND POLLOCK, LTD., OLDBURY.

(*For Description, see Page* 161.)

Fig. 12. Inert-Atmosphere Annealing Furnace.

Fig. 13. Vertical Electric Heat-Treatment Furnace.

Fig. 14. Straightening Tubes By Eye.

ENGINEERING

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

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ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

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ENGINEERING

FRIDAY, AUGUST 7, 1953.

VOL. 176. No. 4567.

ROAD RESEARCH.

THE misuse of the Road Fund is a perennial complaint of all road users. That the Road Fund has never been in active existence, so that monies levied from the vehicle owner and intended for the Fund cannot be applied in the manner originally envisaged, does not materially affect the issue. The complaint is an old one, as is the response of successive Governments, of whatever political shade, that the country "cannot afford it"—"it" being the upkeep of existing roads where they are otherwise satisfactory, the reconstruction of those that are hopelessly inadequate, and the construction of new roads to meet the needs of a still-expanding internal road transport. No engineer will accept the suggestion that work on the road system of the country should not rank as a major national requirement of the highest priority; the unseen losses due to poor roads—wastage of time for men and materials, wear and tear on vehicles, and a large contributor to road accidents—are obviously too great.

One small glimmer of light exists to penetrate the murk and to suggest that, some day, some Government will authorise a serious attack on the menace of bad roads. This ray of hope lies in the existence of the Road Research Board and the Road Research Laboratory of the Department of Industrial and Scientific Research. Their reports are published annually and that for 1952 has just appeared.* The small measure of hope for the future that is given to the vehicle owner must inevitably be diminished, however, by the opening paragraph in the report of the Board, which notes, with concern, that recent cuts in expenditure and in the complement of the laboratory "have resulted in a serious slowing down of planned development of the laboratory's work." The Board consider that, "despite present conditions, road research should be developed in accordance with earlier plans . . . since relatively small outlays on research on roads have saved many lives and many millions of pounds each year"; and state categorically that they do not believe that a reduction in expenditure "on investigations designed to increase our knowledge of road problems" is, in fact, an economy. To this we would add that, if work is not soon undertaken on a major scale, the situation will be so out of hand that it will become beyond remedy, for the engineers who are competent to deal with the problem will have taken themselves off elsewhere; they cannot continue working *in vacuo* for an unlimited period without seeing material improvement arising from their efforts. The failure of authority to put to sufficient use the knowledge and efforts of the research staffs is one of the most significant factors contributing to the wholesale resignations from Government establishments.

The work of the laboratory is divided into two parts, that on traffic and road safety being done at Langley, and that on materials and construction at Harmondsworth. That these two divisions of what is really one problem should be studied at separate establishments forms a serious hindrance to the efficient prosecution of the work, and is an added indication of the failure of the Government to appreciate the importance of the contribution that the laboratory can make to the country's economy and well-being. The Board are able to note, however, that there is a "good prospect" of obtaining a site that will enable the two parts of the laboratory to be brought together, which affords some ground for satisfaction.

An aspect of the work of the laboratory that has not been appreciated sufficiently in the past is that which concerns the equipment of road vehicles. An example of this work, which, fortunately, has received considerable publicity and on which authority has acted, concerns the rear lighting of the vehicles. Not only has authority acted, but so have the vehicle builders, who are giving every consideration to the recommendations of the laboratory and are making appropriate modifications to new cars and lorries, as well as to existing vehicles. A small but significant section of the Director's report for 1952 relates to the shortcomings of existing headlights and side lights. Particularly does the report draw attention to the bad alignment of headlights, noting that 15 per cent. of stem-mounted lamps on cars are aimed well above the horizontal and that 40 per cent. well below it. In either case, such lamps give the driver an inadequate light and allow him to be easily dazzled even by lamps that are correctly mounted. The great improvement that has been achieved in this respect in the modern car fitted with flush-mounted lamps is also recorded, as is the general superiority of lorries to privately-owned cars in this matter of adequate front lighting.

In the same division, of vehicle equipment, measurements made in recent "safety weeks," using apparatus for recording the maximum braking force at the individual wheels of vehicles in use showed that 30 per cent. of cars had virtually no braking on one or more wheels. Unless all the wheels of a vehicle are equally retarded, varying conditions may arise; if the rear wheels only are braked, there is a tendency for the vehicle to turn round. If

* *Report of the Road Research Board*, 1952, Department of Scientific and Industrial Research. H.M. Stationery Office, Kingsway, London. [Price 4*s.* 6*d.* net.]

only the front wheels are braked, the vehicle will continue in a straight line and cannot be turned off that line so long as the front wheels remain locked. In this connection, the report notes with interest that most post-war cars have a brake distribution which provides for more braking on the front wheels than on the rear, so that there is a greater tendency towards front-wheel locking when emergency braking is applied. In contrast, pre-war cars—with equal brake distribution and with the inevitable forward transfer of load which occurs on braking—have a marked tendency for the rear wheels to lock before the front and for the car to deviate considerably from its path.

Work has continued with traffic investigations such as those into the effect of signal-controlled intersections of parking and of road-markings on the behaviour of traffic; and studies have been continued on traffic flow and the capacity of roads for traffic. Means of promoting traffic flow are continually being sought at the laboratory with the object of reducing the cost of road transport.

The greater part of the Director's report is concerned with materials and methods of construction. Soil stabilisation continues to be a major subject for investigation, as do various aspects of concrete technology. New, among the items mentioned in these annual reports, is a short note concerned with air-entrained concrete. Briefly, this involves the use of various compounds that, when added to the concrete during mixing, produce numerous minute bubbles of air. The presence of the air serves to improve the workability of the concrete by a lubrication effect, improves the resistance to frost, and reduces the water absorption of the set concrete. On the other hand, the entrained air brings about a reduction in strength of concrete of any particular composition, and the laboratory would appear to recommend the use of air-entrained concrete only for the limited case of housing-estate road. Surface dressings of all types, as well as the pavements themselves, continue to be the subject of full-scale tests in many parts of the country, and detailed notes of the form of the experimental road laid at each site, together with interim reports on the behaviour and durability of the materials, are given in an appendix.

During 1947, when the winter was particularly severe, many important roads became blocked by snow and the national economy was seriously affected; even in normal years, the expenditure of British highway authorities on snow removal, salt treatment of snow-covered and icy roads, and spreading of abrasives is of the order of two or three million pounds. Experiments are therefore being made at the laboratory to determine the best type of snow fence to use to cause drifting snow to be deposited elsewhere than on roads; this problem has been tackled in two ways simultaneously, the full-scale prototype erected in suitable countryside in Inverness-shire and Derbyshire, and model tests in a wind tunnel. From the observations already made, it has been found that a fence having an area density of 50 per cent. (equal widths of slabs and spaces) was most efficient, holding back nearly half as much again as the solid fence of equal height. A small, but critical, feature of the design of such fences was found to be the great value of a clear gap of 6 in. to 9 in. below the fence, in preventing it from becoming snowed-up prematurely.

Laboratory experiments have also been devised to examine the requirements for improving the design of snow ploughs. The full-scale alteration of such machines would have been too expensive to consider for experimental purposes alone and, anyway, real snow is seldom available in the fresh condition. Consequently, model tests are being made which makes the alteration of the blade shape quite inexpensive, and the snow is satisfactorily replaced by dry sawdust. Under the best conditions of operation, the overall mechanical efficiency of either the blade or rotary-type of plough rarely exceeds 25 per cent. and it may be less than 5 per cent. under average conditions. Preliminary efforts are therefore being concentrated on studying the various ways in which power is lost, and the theory of dimensions has been employed to deduce the relevance of the experimental conditions. It is evident from the report that the roads problem could now be attacked with the aid of much knowledge acquired by hard experience and well-analysed experiment.

EUROPEAN WATER POWER.

In a report published last year by the United Nations Economic Commission for Europe, it was pointed out that the consumption of electricity on the Continent was doubling every ten years; but, as the areas of heavy consumption, to a considerable extent, do not coincide with those rich in natural power resources, various international power interconnections were suggested. The construction of a power grid embracing such countries as Yugoslavia, Albania, Austria, Hungary and Greece, all of which countries were mentioned in the proposals, presupposes a degree of international economic co-operation which is far from having been achieved at the present time. Presumably, however, it is the business of the Economic Commission for Europe to do all it can to encourage the growth of economic co-operation, and one method of doing this is to collect and publish the technical data on which practical measures must be based. The most enthusiastic political convictions about the value of international economic interworking may do more harm than good unless they are based on sound technical grounds.

The Economic Commission has now made a further contribution towards the establishment of an accurate body of knowledge about both the physical and the economic power potential of the countries of the Continent, economic potential by no means necessarily corresponding with the physical. The Commission's report,* a substantial volume of some 180 pages, is based on official returns published in various countries and on papers presented to the World Power Conference and other organisations. These diverse sources naturally vary in reliability and in the methods employed in computing potential. It is claimed that the main value of the report lies in the fact that "the theoretical gross potential of the various European countries" has been estimated on a uniform basis.

Three types of potential are specified: the theoretical gross, the technically exploitable and the economically exploitable. As the theoretical gross potential may be stated, in brief terms, to be determined by stream flow, and as the report states that "deficiencies in hydrologic records are important . . . in the United States," it is hardly likely that much reliance can be placed on the figures available for some of the more backward European countries. As the whole purpose of the report is to assess the standing of the various countries in the overall computation of European water power, the theoretical gross potential is obviously of basic importance. This may be calculated from the total land surface in each river basin, in conjunction with rates of precipitation and stream-flow data, and the report contains a long table showing the distribution of gross hydro-electric potential throughout Europe. The overall picture presented by this table is probably broadly correct, but for many countries, or rivers, it is based on inadequate data and should be understood in a qualitative rather than a quantitative sense.

If the estimation of gross potential is difficult, the estimation of technically exploitable potential is more so. The possibility of developing any water-power site is dominated by engineering considerations and its practicability can only be determined by detailed surveys. The report is not concerned with particular applications, and, while it admits that "no universally valid criteria can locate the exact limits for a particular watercourse without inspection on the ground," it claims that valid comparison between gross and technically exploitable potential can be made "in developed countries." This last clause is important, as the method involves cataloguing all usable sites, calculating plant capacity on the basis of long-term mean flow, applying coefficients for loss of head and machine efficiencies, recording flow and storage capacity, and other relevant matters.

This, however, does not necessarily constitute a method of selecting worth-while schemes. Projects have still to be considered from the point of view of economic exploitation. The distinction made in the report between technical and economic potential is somewhat artificial. No engineering scheme is, in the long run, technically sound if it is not economically sound. To illustrate what is meant by economic potential, it is pointed out that, when a water-power scheme is being studied, regard must be had to the possibility of generating more cheaply in steam stations, which, in turn, will be related to the cost of fuel; and that interest rates may have a determining influence on the magnitude of capital expenditure. All these matters, of course, come into consideration when the technical details of any hydro-electric scheme are being worked out.

It is claimed that both the technical and economic levels of exploitability "tend to vary fairly consistently with the gross power of flow and head," and "tentative general conclusions" are drawn about the availability of unused water power in some selected countries. In Austria, for instance, it is estimated that there is a gross natural potential equivalent to an output of 152 thousand million kWh in an average year, although previously published estimates vary between 19 per cent. and 26 per cent. of this figure. Only 20 per cent. of the lowest estimate has yet been developed. It is considered that power equivalent to 60 thousand million kWh is physically exploitable. In Czechoslovakia the theoretically possible is 39 thousand million kWh, but only 18 per cent. of this has officially been considered to be economically exploitable. The studies on which the report is based lead to the conclusion that this figure might be raised to 21 per cent., but not higher. In France, with 255 thousand million kWh theoretically available, it is considered that the present official figure of 60 thousand million kWh, practically available, may be capable of "limited increase," particularly by the development of Alpine tributaries of the River Rhône.

Estimates similar to the above have been made for Germany, Italy, Poland, Switzerland and Yugoslavia, and the general conclusion drawn is that the "economic potential" for Continental Europe may be increased by some 20 per cent. over previous estimates, representing about 50 thousand million kWh. The main exploitable reserves are in Italy, Austria and Switzerland. In Italy, the hydrologic characteristics of the river basins make comparisons difficult with other areas except those lying in Alpine regions, but the percentage of gross energy potential which has been harnessed is significantly lower than that of other countries with gross possibilities of similar importance, and it is thought that there is "plenty of room" for the economic limits of production to be raised. In Switzerland, even "official estimates" of economic potential leave "plenty of energy in reserve for future use."

* *Hydro-Electric Potential in Europe and its Gross, Technical and Economic Limits.* Economic Commission for Europe. Palais des Nations. Geneva, Switzerland. [Price 1 dol., 7*s.* 6*d.*, or 4 Swiss francs.] London Information Centre, Russell Square House, Russell-square, London, W.C.1.

NOTES.

THE DE HAVILLAND "GYRON" JET ENGINE.

THE DE HAVILLAND ENGINE COMPANY, LIMITED, Edgware, Middlesex, state that, after some years of development work, they have produced a new type of jet aero-engine, the Gyron, which, on tests extending over "a substantial running period," has been giving a thrust "greater than announced for any other jet engine." The engine is of the axial-compressor type, of exceptional simplicity and low weight, and is now being developed under a Ministry of Supply contract for use in fighter aircraft of supersonic speed. For security reasons, the Ministry will not permit the publication of any illustration or details of the new engine, but it is stated to have given, on test, "satisfactorily low specific consumptions and a high degree of reliability." It has been designed by Major Frank B. Halford, C.B.E., F.R.Ae.S., the chairman and technical director of the de Havilland Engine Company, in association with Dr. E. S. Moult, M.I.Mech.E., the company's chief engineer, Mr. F. M. Owner, C.B.E., M.Sc., the deputy chief engineer, and Mr. W. H. Arscott as chief designer. The production of the engine has been the responsibility of Mr. A. F. Burke, O.B.E., managing director, and Mr. J. L. P. Brodie, M.I.Mech.E., who is the director in charge of the Engineering Division of the company.

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH.

A convention for the establishment of a European Organisation for Nuclear Research was signed in Paris on Wednesday, July 1, by representatives of Belgium, Denmark, France, the German Federal Republic, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslavia. It will take effect when the signatures have been ratified by the legislatures or governments of Switzerland (the host country) and six other nations. The purpose of this new organisation is to "provide for collaboration among European States in nuclear research of a pure scientific and fundamental character." It will have no concern with military requirements and the results of its work will be made generally available. The basic programme of the organisation will include the establishment of a laboratory about three miles west of Geneva, near the French frontier, for research on high-energy particles, including cosmic rays. International co-operation in these subjects outside the laboratory will also be sponsored. The laboratory equipment will include a synchro-cyclotron capable of accelerating protons up to about 600 million electron-volts, which will be ready for operation in 1957. There will also be a proton-synchrotron which will generate energy at 10,000 million electron-volts, and perhaps at as much as 30,000 million electron-volts. This will have a circular magnet, with a diameter of about 300 m., which will be situated underground. When the new organisation comes into existence, the European Council for Nuclear Research (CERN), which was established in February, 1952, will automatically go out of existence.

THE MONOPOLIES COMMISSION AND SEMI-MANUFACTURES OF NON-FERROUS METALS.

As announced in a written Parliamentary answer on July 28, the Board of Trade have varied the terms of the reference made to the Monopolies and Restrictive Practices Commission on December 12, 1950, about certain semi-manufactures of copper and copper-based alloys. The reference originally limited the Commission's investigation to the facts about supply in the United Kingdom and exports; they reported on this subject on April 20, 1953. The original reference asked for a report on "(1) whether conditions to which the (Monopolies and Restrictive Practices) Act applies in fact prevail, and, if so, in what manner and to what extent; (2) the things which are done by the parties concerned as a result of, or for the purpose of preserving, those conditions." The variation now made requires the Commission to report "whether the conditions in question or all or any of the things done as aforesaid operate or may be expected to operate against the public interest." Their completed report will be laid before Parliament in due course, in accordance with Section 9 of the Monopolies Act. Reports of the Commission have already been published on the subjects of dental goods, cast-iron rainwater goods, electric lamps, insulated electric wires and cables, insulin, and matches and the match-making machinery. The Commission hope to report on imported timber during the summer, and on the printing of woven fabrics before the end of the year. Apart from the requirement for a report under Section 15 of the Monopolies Act about the general effect on the public interest of certain widely prevalent discriminatory practices, the other subjects at present before the Commission are certain electrical and allied machinery and plant; pneumatic tyres; and buildings in the Greater London area. It is expected that at least one reference on a new subject will be made shortly.

LETTERS TO THE EDITOR.

THE STATUTORY DUTY OF AN EMPLOYER.

TO THE EDITOR OF ENGINEERING.

SIR,—In the issue of ENGINEERING of January 30, 1953, you printed a leading article on the above subject, in which it was pointed out that, when a contract of service is entered into, it is to be inferred that, under the common law, the servant takes upon himself the ordinary risks incident to such business as is carried on upon his master's premises. Nevertheless, if a statutory duty is imposed on the master, he is responsible if damage or injury results from non-performance. You then drew attention to the case of *Lay* v. *D. and L. Studios* (1944), 1 All E.R. 322, in which it was alleged that there had been a breach of one of the Woodworking Machinery Regulations, made pursuant to the Factories Act of 1937; but did not emphasise the fact that a regulation properly made has all the force of the statute itself. That being so, it will be strictly construed, and the mere fact that a Minister makes a regulation which, on the face of it, appears to apply to a particular process, does not prevent an employer from arguing to the contrary.

This point was referred to in the recent case of *Rees* v. *Bernard Hastie & Co., Ltd.* (1953), 1 A.E.R. 375. The facts were as follows. A workman was cutting sheet metal with a machine, electrically driven, the operation of which did not involve the application of heat. A strip of metal, which he was cutting, sprang up and injured his eye. His employers had not provided him with goggles or a screen. An action was brought against them, it being alleged that there was a breach of the Factories Act, 1937, s. 49, and the Protection of Eyes Regulation, made thereunder. That section provides that "in the case of any such process as may be specified by regulations of the Secretary of State, being a process which involves a special risk of injury to the eyes from particles or fragments thrown off in the course of the process, suitable goggles shall . . . be provided to protect the eyes of the person engaged in the process." Regulations made in 1938 apply this section to, *inter alia*, the "Welding or cutting of metals by means of an electrical, oxy-acetylene or similar process." The word "similar" is to be emphasised, for a reason to be mentioned presently.

It was contended on the part of the plaintiff that the regulations covered any form of cutting, if the power which enabled the steel to be cut was electrical. Counsel for the defendants, on the other hand, contended that the regulations covered cutting only where the electrical process involved a high temperature. The judge who tried the case came to the conclusion that the wider construction contended for by the plaintiff was right. He took the view that that was not a matter which it was open to him to consider, and that the Secretary of State was the sole judge; and that, as the process had been specified in a regulation, it was not open to anyone to say it was not a process which involved a special risk of injury to the eyes. Therefore, he found for the plaintiff, and awarded damages.

The matter did not rest there, however. In the Court of Appeal, it was held that the electrical process dealt with by the regulations was a high-temperature process, namely, the use of an arc. Mr. Justice Somervell said: "The fact that the regulation covers welding or cutting indicates that the process dealt with, whether oxy-acetylene or electrical, is one which can be used for either purpose and the word 'similar' indicates a similarity in the danger to the eyes with which the regulation deals . . . If it is read as including all processes of cutting when electrical power is used, it is obvious that the dangers, if they existed, would be of a different character. Presumably, the words 'similar process' were inserted to cover chemical means of obtaining a very high temperature other than by the combination of oxygen and acetylene, if they exist."

In the course of his own judgment, Lord Justice Romer said that he was not sure whether the judge in the Court below was laying down that the fact that the Minister made a regulation established its validity. He said: "On the view that we take as to the meaning of this regulation, this point need not be decided and must be left open . . . but I should hesitate to adopt that view as at present advised, because . . . the words 'being a process which involves special risk of injury' are nothing more than a direction to the Minister . . . It may be that as there are no such words as 'being in the opinion of the Minister a process which involves special risk, etc.,' it would be open to an employer to prove, if he could, that the process which is the subject of the regulation is not one which involved special risk of injury." In the result, the appeal was allowed.

Yours faithfully,
W. VALENTINE BALL.

The Athenæum,
Pall Mall, London, S.W.1.

ALUMINIUM AS A STRUCTURAL MATERIAL.

TO THE EDITOR OF ENGINEERING.

SIR,—May I be permitted to correct a mis-statement made in the most interesting article on "Aluminium as a Structural Material," by M. Bridgewater, which appeared in your issue of June 19. Mr. Bridgewater states that a practical outcome of the experimental work on the Arvida Bridge was the development of the recessed rivet head. Actually, however, it was the annular rivet head which was developed at that time, as described in the article entitled "Cold Riveting of Aluminium," by Mr. Ernest Anders and the writer, which was published in your issue of August 11, 1950.

Yours sincerely,
D. G. ELLIOT.

Aluminium Laboratories, Limited,
Montreal, Quebec, Canada.
July 28, 1953.

WHAT IS MOVING MACHINERY?

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad that, in your article with the above title, on page 99, *ante*, you called attention to the decision of the Court of Appeal in the case *Cummings* v. *Richard Thomas and Baldwins, Limited*. The verdict seems to result in the establishment of an almost impossible position. I find it very difficult to believe that the intention of the Act, in using the words "in motion or in use," really was to cover the conditions of repair which obtained when the accident in question happened.

Yours faithfully,
For and on behalf of
SMALL ELECTRIC MOTORS, LIMITED,
R. T. MEDD,
Managing Director.

Eagle Works,
Churchfields-road,
Beckenham, Kent.
July 27, 1953.

WELDED ALUMINIUM-ALLOY YACHT.

SAUNDERS-ROE (ANGLESEY), LTD., BEAUMARIS.

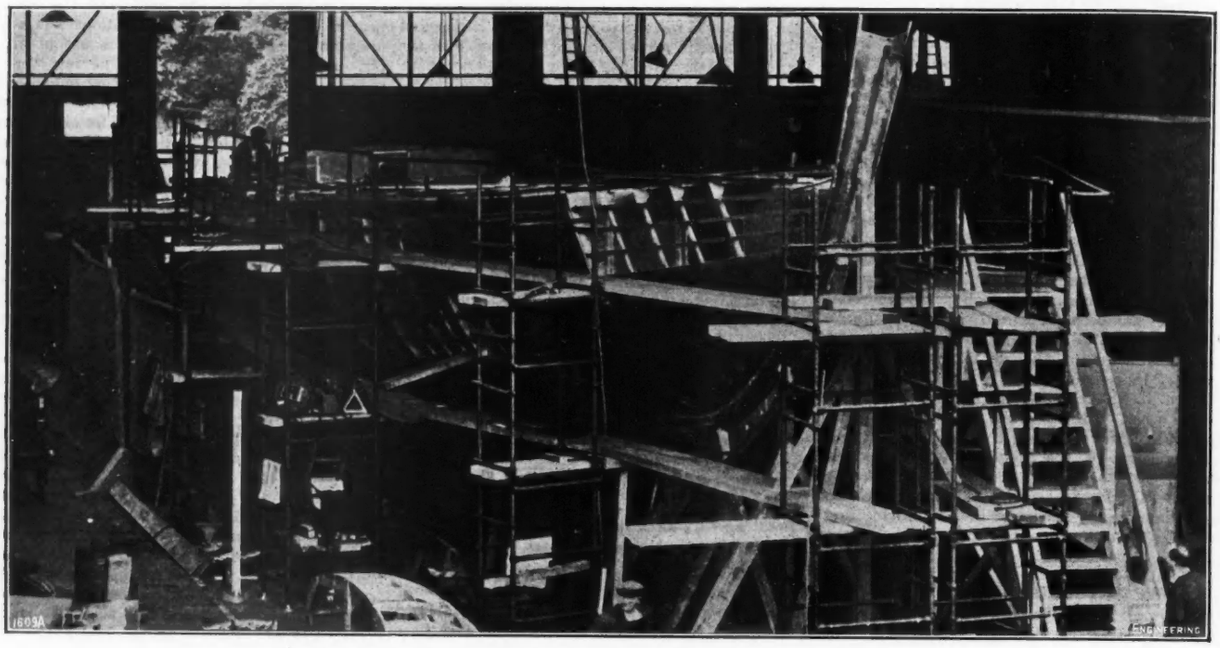


FIG. 1. VESSEL UNDER CONSTRUCTION, FRAMED AND PARTLY PLATED.

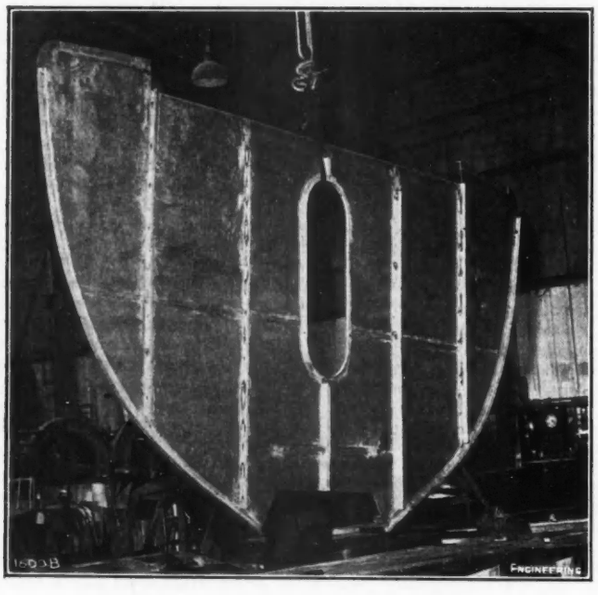


FIG. 2. PREFABRICATED BULKHEAD.

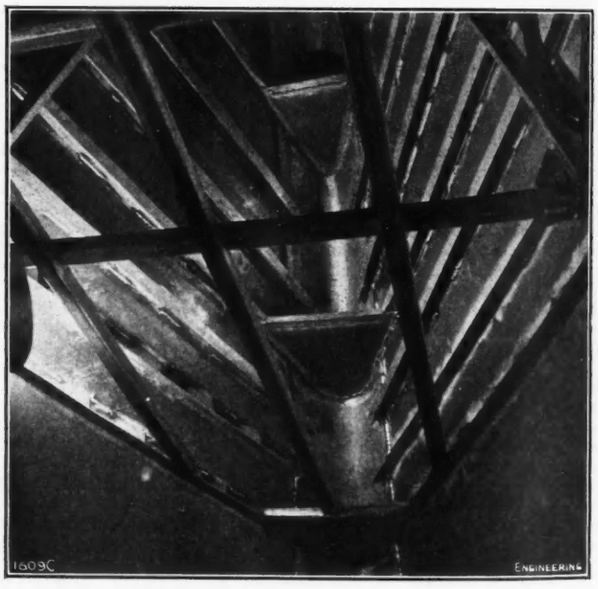


FIG. 3. INTERIOR OF FOREPEAK.

ALL-WELDED ALUMINIUM-ALLOY YACHT.

THE use of aluminium alloys in the construction of motor and sailing yachts, and of ships' lifeboats, is not new, and their employment in the superstructures of liners has developed rapidly in the past few years; but in most of such instances riveting has been the means of attaching the plates to each other and to the frames. A special interest attaches, therefore, to the all-welded motor yacht Morag Mhor, at present under construction for the British Aluminium Company at the works in Beaumaris, Anglesey, of Saunders-Roe (Anglesey), Limited. The Morag Mhor, which is 72 ft. 3 in. in length, has been designed by Laurent Giles and Partners, Limited, naval architects, of Lymington, Hampshire, in conjunction with the Saunders-Roe staff, for the purpose of demonstrating the possibilities of welding by the self-adjusting arc process, as applied to aluminium and its alloys, for ship construction. The scantlings of the hull are similar to those used in the deckhouses and superstructures of ships. It may be remarked that the British Aluminium Company are among the largest producers in this country of aluminium-alloy plate for ship construction and have had considerable experience in this field, using riveted fastenings. It has been found that, by the use of welding, considerable savings can be effected in both material and cost; partly by the elimination of plate overlaps and the wide flanges on sections, which are necessary for riveting, and partly in labour cost, because fewer processes are involved in preparing the work. There is also, of course, a considerable saving in weight, compared with that of a steel hull of the same dimensions.

The hull of the Morag Mohr, which is stated to be the largest yet constructed by welding in any country except the United States, is framed on the longitudinal system and has nine bulkheads. A general view of the vessel partly plated is given in Fig. 1, herewith; and Figs. 2 and 3, on this page, and Figs. 4 to 7, opposite, show details of the construction. In general, the frame spacing is 3 ft. The shell plating is welded directly to the longitudinals, of which there are ten on each side, and to the bulkhead boundary bars, through which the longitudinals are continuous; but there is no connection between the shell plating and the intermediate transverse frames, as these are welded to

WELDED ALUMINIUM-ALLOY YACHT.

SAUNDERS-ROE (ANGLESEY), LTD., BEAUMARIS.

FIG. 4. DOUBLE BOTTOM, CONTAINING WATER TANKS.

FIG. 5. KEEL, LOOKING FORWARD.

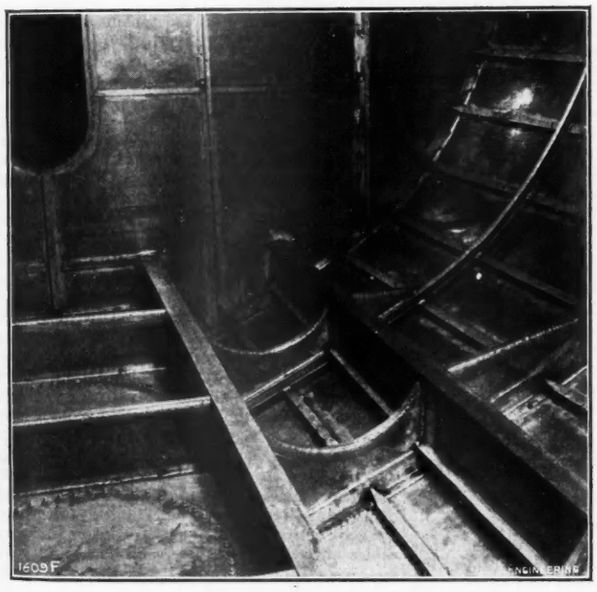


FIG. 6. STARBOARD ENGINE BEARERS.

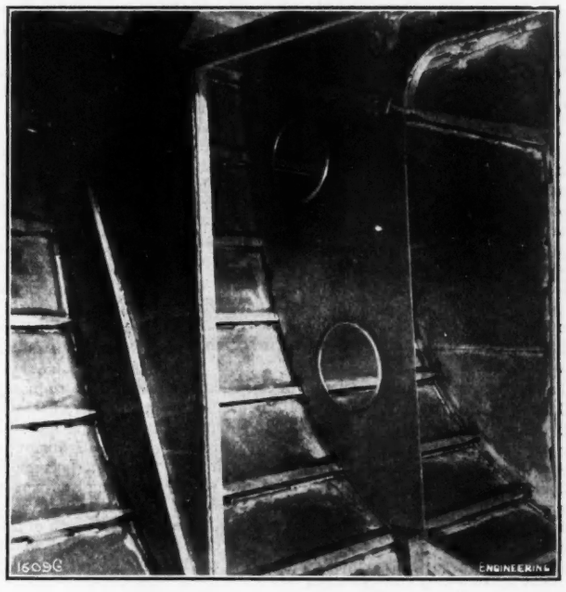


FIG. 7. STARBOARD FUEL TANK.

the inboard flanges of the longitudinals. This feature can be seen in Fig. 6, which is a view in the engine room, looking forward. The shell seams are butt-welded and are arranged to come in way of the longitudinals, which therefore act as backing bars to the welds. For the same reason, the shell butts fall on the boundary bars of the bulkheads.

As the vessel is intended for sailing, a deep fin keel is provided. It is illustrated in Fig. 5 and is formed hollow to contain the 8 tons of iron ballast, which is prevented from moving (and from contact with the aluminium of the keel structure) by being "packed" with a bituminous compound. The keel is subdivided by floor plates at each frame and bulkhead and, as the upper part of it is the line of double-bottom tanks to be seen in Fig. 5, it forms a longitudinal girder of great strength. The tanks will be used to hold fresh water, the fuel (800 gallons) being carried in two wing tanks in the engine room. The starboard tank, with its central stiffening plate, but without the vertical plate forming its inboard side, is shown in Fig. 7, herewith. This illustration also shows how the flanges of the continuous longitudinals are cut away at the points of intersection with the bulkhead boundary bars. We understand that stiffening gussets are to be welded to the top flanges of the longitudinals and to the bulkheads, etc., at these points; though, when we had an opportunity to inspect the vessel recently, these were not in place.

The hull plating is all of the British Aluminium Company's BA.M27 alloy, and conforms to the British Standard specification Nos. 1477-1951 (NP 5 and 6). The stem is fashioned from BA.M27 "flanging quality" plate, and all material of sheet thickness is of BA.M27 composition to NS6-¼ hard properties. The sections used are extruded in NE6 material (BA.28), and the rivets are of N5 composition. The filler wire used for welding contains 5 per cent. of magnesium, to Specification NW6. Over the 'midship portion of the hull, the deck-edge plate, which, like the stem, is of 0·25-in. flanging quality BA.M27 alloy, is worked to a transverse radius of about 6 in. and butt-welded to the top edge of the sheer strake and the outboard edge of the deck stringer plate. This form increases the strength of the hull as a girder and simplifies its construction by comparison with the more normal method of joining the sheer strake and the deck stringer by a gunwale angle; a gunwale angle, however, is used towards the bow and stern of the vessel.

Certain of the scantlings have been given above; the others are as follows. The flat-plate keel, which is the heaviest, is ⅜ in. thick. The central stringer plate of the deck, like the deck-edge plates, is ¼ in. and the remainder of the deck plating ⅛ in.

The tank margin-plate is ½ in. thick and the tank top 0·20 in. The stem and the keel side-plates are ⅜ in and the garboard strakes are 0·275 in. and the rest of the shell plating ¼ in. The hull longitudinals are I bars, 1⅜ in. by 1⅛ in. and ¼ in. thick. Channels are used for the hull frames, which are 1½ in. by 1 in., with flanges ¼ in. thick and a ⅛-in. web; and for the deck longitudinals, which are 1⅜ in. by 1⅜ in. and ¼ in. thick, and the deck beams, which are 1⅛ in. by 1⅜ in. and ¼ in. thick.

The length of the vessel overall, as stated above, is 72 ft. 3 in. The length on the datum waterline is 60 ft. 4 in., the beam 16 ft. and the draught 7 ft.; and the displacement is 45 tons. There are two masts, namely, a mainmast 70 ft. in height and a mizenmast of 46 ft. 6 in. The mainsail has an area of 671 sq. ft., the mizen 317 sq. ft. and the staysail 420 sq. ft., making a total of 1,408 sq. ft. Both masts are fabricated from BA.M27 plate, that of the mainmast being 0·25 in. thick and that of the mizenmast 0·20 in. They are of elliptical section and are formed by rolling two plates to half-section profile and joining them by two longitudinal butt-welds, one on each side of the mast. They are constructed in lengths of about 10 ft., joined by circumferential butt-welds. The cross section of the mainmast is 14 in. by 11 in., tapering to 6½ in. diameter at the truck, and the mizenmast is 10 in. by 8 in., tapering to 5 in. in diameter.

The accommodation provided is as follows. Abaft the forepeak there is a cabin with two berths, and aft of this cabin, but separated from it by a toilet on the starboard side and a shower bath to port, there are two single cabins. A central passage leads aft between these cabins to the engine room, which extends to the full breadth of the hull. Aft of the engine-room bulkhead, which has no door opening, there is a single cabin on the port side and, on the starboard side of the central passageway, which is entered by a companionway from the deckhouse lobby on the starboard side, there is a compartment containing a toilet and shower. At the after end of the passage is a double cabin. The remaining space consists of stores. In the deckhouse there is a roomy saloon forward; the lobby, previously mentioned, on the starboard side amidships and the galley to port; and, abaft these, the wheelhouse, which has a raised deck to afford a clear view ahead over the top of the saloon. This superstructure is of double-skin riveted construction, the stiffeners between the inner and outer skins also serving as spacing members. The inner skin is of 16-s.w.g. sheet and the outer skin 18 s.w.g. Stowed on the after deck there will be two boats, both of welded aluminium alloy, namely, a 12-ft. launch fitted with a Stuart Turner engine of 4 h.p., and a 10-ft. sailing dinghy.

The propelling machinery consists of two Gleniffer DB.6 six-cylinder four-stroke Diesel engines, each delivering 72 brake horse-power at 1,000 revolutions per minute. They will drive directly, through Anderton clutches, three-bladed variable-pitch propellers 26 in. in diameter and will give the vessel a speed of 12 knots. The propellers were designed and supplied by Slack and Parr, Limited. Engine cooling is by fresh water, recirculated on a closed system through surface cooling tanks built on to the shell plating in the engine room.

We may mention that the contract to build the Morag Mhor was awarded to Saunders-Roe (Anglesey), Limited, as a result of competitive tendering. The firm have had considerable experience in the use of light alloys for marine applications and have carried out a variety of work at their Beaumaris yard since they established themselves there in 1945, after their yard at Cowes, Isle of Wight, was destroyed by enemy action. They have built at Beaumaris two types of airborne lifeboat, the later of which is designed to be carried and launched by Shackleton aircraft; light-alloy pontoons and motor tugs for use in military bridging operations; torpedo tubes, depth-charge chutes and recompression chambers for the Admiralty; and in 1948, also on Admiralty account, a 75-ft. motor torpedo-boat, P1602, which was the first vessel of that type to be constructed throughout of light alloy. They also produce omnibus bodies in similar material, made in sections so that they can be shipped abroad in "knocked-down" condition, and readily re-erected.

All forms of welding are in use at the Beaumaris yard, including the argon-arc, Aircomatic and consumable-electrode processes. The equipment used on the Morag Mhor is of two kinds, namely, the Aircomatic, which is of American origin, and the British Oxygen Company's Argonaut type, both employing the self-adjusting arc.

WELLPOINT WITH IMPROVED FILTER.

Wellpoints are used for de-watering sands and similar strata where the finer particles would otherwise flow with the draining water, to be drawn into the pump if simple pumping from open sumps were employed. Apart from the wear on the pumps, there is a danger of settlement in adjacent properties if finer sands are removed with the water. The principle of de-watering by wellpoints has been known and used for many years, the principle being to lower the level of the ground-water round an excavation by pumping from a number of surrounding bore-holes. The wellpoint comprises a central tube which is surrounded by a filter, usually of wire mesh, and equipped with a cutting and jetting shoe with a non-return valve at its lower end. This cutting shoe enables the wellpoint to be sunk into position, using a high-pressure water jet to facilitate its insertion into clay or gravel strata. When suction is applied to the riser pipe connecting the pump to the wellpoint, the non-return valve closes, thus sealing the open end of the cutting shoe; the suction is then transferred to the filter through ports at the bottom end of the central tube. Water, or, more often, a mixture of air and water, is drawn through the filter and up the riser pipe, the filter preventing the entry of solids to the pumping system. The principal disadvantage of this type of wellpoint in its conventional form is the heavy wear which occurs to the wire mesh when jetting into the ground and on subsequent reclamation of the wellpoint.

In an endeavour to reduce the cost of maintenance, a new form of wellpoint has been devised by the Mechanical Development Section of the Central Laboratory of George Wimpey and Company, Limited, Southall, in which the filter action is achieved in the gaps between washers instead of through a wire mesh. The washers are of two types which are used alternately when building up the filter, for which about 500 washers are required; they have an outside diameter of 3½ in. and are punched from ¼ in. metal sheet. The gaps for the filter paths are formed between successive washers by small upstanding protrusions, 0·012 in. high, raised on each side of one of the types of washer, which is also notched round the periphery; the other type of washer has a series of holes punched through the annulus. To maintain the filter paths, correct alignment of successive washers is ensured by small lugs on one washer nesting into corresponding notches in the adjacent washer. The total length of the filter is 2 ft. 11½ in. and the overall length of the wellpoint 3 ft. 11½ in.

The operation of this improved wellpoint has been found to compare favourably with that of the older types. Owing to the much reduced diameter of the inside of the washer, compared with the external diameter, very little of the force of the water stream used for jetting is lost through the lower ports and outwards through the washers; this loss was one of the disadvantages from which earlier patterns suffered, and extra sliding valves had to be fitted to prevent it. It is claimed that the construction of the new wellpoint is sufficiently rugged for it to be installed and removed with greater force than with older types, there being no fear of damage to the mesh during installation, with consequent entry of sand into the system. It is also claimed that the washers give an exceedingly high degree of filtration and that, therefore, the wellpoint can be used in sands of finer grain than would be possible otherwise. It can be easily cleaned by unscrewing the top clamping screw to loosen the washers and by then shaking while water is pumped through it. The weight is less than that of other existing types. The cost is somewhat greater, but this is offset by longer life and improved performance.

FIRE-RESISTING ELECTRIC CABLES.

A new range of cables, insulated with asbestos-paper tape, has been developed by Pirelli-General Cable Works, Limited, 343, Euston-road, London, N.W.1, for use on circuits operating at voltages up to 660 volts where resistance to fire, non-inflammability, non-ageing, and the maintenance of electrical properties at high temperatures are required. The copper conductors, which may be single or stranded, are lapped with asbestos tape and the cores are then laid up, asbestos-paper taped, and sheathed either with aluminium or stainless steel. In the smaller cables of the former class, to which the name Asbestal has been given, the cold-welded sheath has a small longitudinal fin, and in the larger sizes the sheath is corrugated and argon-arc welded. This gives a degree of flexibility comparable with that of a lead-sheathed cable, with the advantage of sufficient stiffness in relation to weight to enable the distance between the supports to be extended. The corrugations also increase the resistance of the sheath to mechanical damage.

Asbestal cables are available in most normal sizes between 1/0·044 and 37/0·103 in single-core, between 1/0·044 and 19/0·072 in twin-core, between 1/0·44 and 19/0·064 in three-core, between 1/0·044 and 19/0·052 in four-core, and between 1/0·44 and 19/0·044 in seven-core. The stainless-steel sheathed cables, which are known as Asbesteel, are similarly available in most normal sizes between 7/0·036 and 37/0·083 in single-core, between 3/0·029 and 19/0·052 in twin-core, between 3/0·029 and 19/0·052 in three-core, between 1/0·044 and 19/0·052 in four-core, and between 1/0·044 and 7/0·052 in seven-core. Telephone cables of multiple twin or quad construction can also be supplied. The multi-core cables have a constant insulation thickness of about 0·05 in. between the conductors, but because of the limited number of sheath diameters, the thickness between the conductors and the sheath may vary, especially on single-core cables.

The asbestos-paper tape has a high degree of resistance to moisture absorption and to destruction by fire, so that the cables can be operated at temperatures up to the melting point of the sheath. Since the insulant is dry, the cables are non-bleeding. They are particularly suitable, therefore, for use on vertical runs which may be subject to overloads or high temperatures. The corrosion resistance of Asbestal cables is similar to that of other types with aluminium sheaths and, generally speaking, is not very different from that of lead-covered cable. When they are to be drawn through ducts, laid directly in the ground or installed in corrosive atmospheres, suitable additional protective covering is recommended. The material usually employed for this purpose is double-taped and compounded polyvinyl chloride, lapped with two compounded glass-staple hessian tapes with a cover of compounded hessian. Asbesteel cables are intended for use where high strength and resistance to mechanical damage are required. The stainless-steel sheath has good corrosion-resisting properties, so that these cables are suitable for use in chemical and rayon factories. When laid directly in the ground they should be protected with the same covering as the Asbestal cables.

The minimum bending radius in installation for the Asbesteel cables and the smaller sizes of Asbesteel cables should be 12 times the overall diameter. Though somewhat less flexible than lead-covered cables, they can generally be handled by normal methods. A beading tool is available for use when required and is recommended when accurate setting is necessary. This minimum bending radius does not apply to the Asbestal cables with corrugated sheaths. Non-plumbing type glands are available, threaded to suit standard conduit boxes and fittings or provided with nuts for fitting to boxes with plain entries.

Research Fellowship on Biosynthesis.—A fellowship to the value of 300*l.* a year for three years has been established by the Dunlop Rubber Co., Ltd., Fort Dunlop, Erdington, Birmingham, at Birmingham University, for research work on biosynthesis, with special reference to rubber.

FITTED-CLUTCH DRIVE.

MARINE ENGINEERING COMPANY (STOCKPORT), LTD., STOCKPORT.

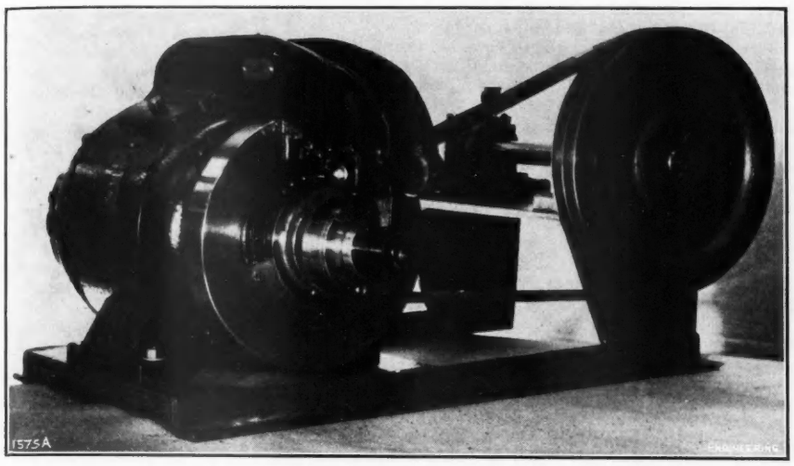
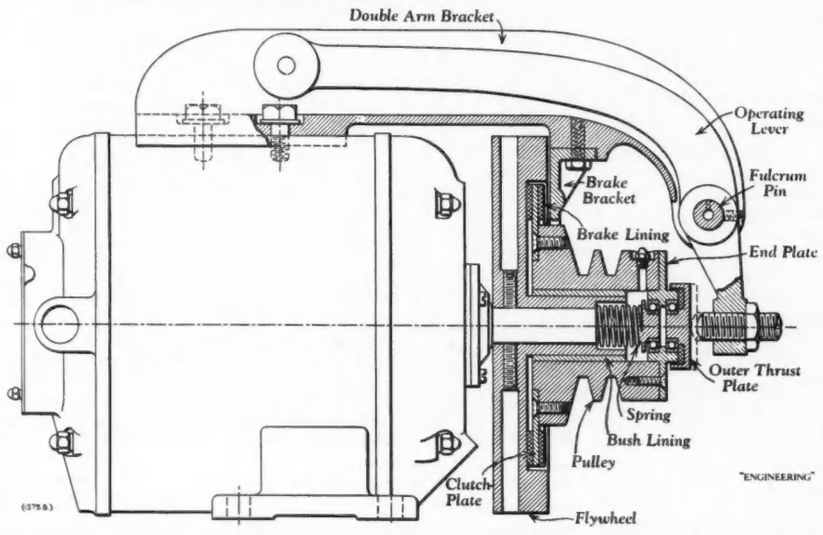


FIG. 1. PROTOTYPE MODEL.

Fig. 2. DETAIL OF CLUTCH DRIVE.



FITTED-CLUTCH DRIVE FOR ELECTRIC MOTORS.

THE purpose of a fitted-clutch drive on an electric motor is to provide a means of taking-off an intermittent motion that can be started and stopped at a greater rate and more frequently than is possible by direct switching of the motor itself. Clutch motors, as they are usually termed, are made by the Marine Engineering Company (Stockport), Limited, Edgeley, Stockport, who have recently produced the improved model which is shown in the accompanying illustrations and described below.

The essential features of all clutch motors are the continuously-running rotor and flywheel assembly, and the combined clutch and pulley member which transmits the drive, usually by V-belts. A prototype motor is shown in Fig. 1, herewith, and a general arrangement of the mechanism in Fig. 2. The flywheel is secured to the rotor shaft and the flywheel spigot, which is of ground steel and projects beyond the rotor shaft, carries the clutch pulley into which has been pressed a sintered-bronze bush. This bush, which must be kept well lubricated, allows the clutch pulley to idle independently of the flywheel. The rotation of the flywheel can be transmitted to the clutch pulley by forcing the pulley inward against the action of the spring on the motor shaft back until the clutch plate engages in a recess in the flywheel. On the front face of the pulley is a steel end-plate which carries two ball races; to the outer of these races is attached the outer thrust cover against which the operating lever presses while the inner race carries the thrust plate for the spring. The projecting end of the flywheel spigot serves as a shroud to the thrust spring which, when the pressure of the lever is relaxed, pushes the pulley forward, putting the clutch out of engagement and simultaneously applying the brake by bringing the annular ring of brake-lining material on the outer side of the clutch plate into contact with the brake bracket indicated in Fig. 2. The clutch-operating lever is carried on a double-arm bracket attached to the rotor housing, and is provided with a screw adjustment.

A pull on the operating lever releases the brake and engages the clutch, thereby taking up the full effect of the kinetic energy of the spinning flywheel and rotor assembly. It is possible to engage and disengage the drive at very high rate, a figure of 50 or 60 times per minute being quoted as typical. The makers state that one user is satisfactorily operating the mechanism 100 times per minute. The methods available for operating the lever will depend upon the particular application; various forms of foot treadle, with either a rigid-link connection or a flexible cable, are used, according to requirements.

The device is available on a wide range of electric motors rated up to about 1 h.p. and suitable for use with all normal mains supplies. The greatest advantages are to be obtained from any form of clutch motor by maintaining a high primary speed in order to gain full advantage from the kinetic energy of the flywheel and rotor assembly. This energy falls off rapidly with a decline of motor speed and, for this reason, full consideration should always be given to utilising a standard motor running at 1,425 r.p.m. (and incorporating a countershaft or worm-gear reduction to the final drive, if necessary) rather than employing a motor of slower speed.

MANCHESTER ELECTRONICS EXHIBITION.

THE eighth annual exhibition of electronic equipment and apparatus, held at the College of Technology, Manchester, between July 15 and July 21, and organised by the North-Western Branch of the Institution of Electronics, is stated to have beaten all previous records for attendance and the number and variety of the exhibits, there having been over 12,000 visitors to the 45 stands, on which were shown examples of electronic apparatus by the leading manufacturers. In addition, there was a programme of 55 lectures by specialists, and a continuous demonstration of research exhibits, television, and scientific films. Emphasis was on the application of electronics to medical research and treatment, an outstanding exhibit being the "heart-lung" machine developed by the Post-graduate Medical School of the University of London. This equipment is designed to take over the function of the human heart in pumping blood through the system, and of the lungs in oxygenating the venous blood, which is pumped through a polystyrene cylinder, designed to present the maximum surface of blood to the action of oxygen. The apparatus is arranged for manual or fully automatic control.

An experimental colour television system, using three 14-in. tubes with dichroic mirrors and coloured phosphors, was shown by Messrs. Ferranti, Limited, who also showed a demountable cathode-ray tube. Fielden Electronics, Limited, demonstrated their proximity meter, operating on the principle of change in capacitance. Applications of this instrument include paint-thickness measurement, and measurements of the irregularity of surfaces. A demonstration of cutting by ultrasonic means was given by Mullard Equipment, Limited. A reciprocating drill vibrates at 22 kilocycles per second, and, with a series of shaped tips, will cut square and other holes in a variety of materials, including glass. Standard Telephones and Cables, Limited, demonstrated their psophometer, which measures interfering noise in telephone circuits in accordance with internationally agreed standards and methods; their industrial electronic counter, as applied to testing the speeds of photographic shutters; and thermistors in use in a six-probe skin-temperature thermometer.

PRIZES FOR SHIPYARD APPRENTICES.—The selection committee of the Worshipful Company of Shipwrights have recommended to the Court of Assistants that the name of Arthur Walkden, shipwright apprentice at the Barrow shipyard of Vickers-Armstrongs Limited, shall be submitted to H.M. the Queen for the award of the Queen's Medal. The committee also recommend the award of a first prize of 50*l.* to Thomas Robinson, shipwright apprentice with Sir James Laing & Sons, Ltd., Sunderland; a second prize of 40*l.* to Ian Fergusson Batte, plater apprentice, Vickers-Armstrongs Ltd., Barrow-in-Furness; a third prize of 30*l.* to Peter Cook, shipwright apprentice, Port Hamble, Ltd., Hamble, Hampshire; and a fourth prize of 25*l.* to David Murray Cowan, shipwright apprentice with Charles Connell & Co., Ltd., Glasgow. Three awards of consolation prizes are also recommended, of 25*l.*, 20*l.* and 15*l.*, respectively, to Edward Wales, plater apprentice, Furness Shipbuilding Co., Ltd., Haverton Hill-on-Tees; Robert George Totty, plater apprentice, Cammell Laird & Co., Ltd., Birkenhead; and Brian Edward Early, boatbuilding apprentice, J. Samuel White & Co., Ltd., Cowes, Isle of Wight.

INDEPENDENT SIDE-BAND COMMUNICATIONS RECEIVER.

AN independent side-band communications receiver has been designed by Messrs. Mullard, Limited, Shaftesbury-avenue, London, W.C.2, for continuous use on long-distance telephone and telegraph circuits. It provides for the simultaneous and independent reception of four telephone channels, each of which has a band-width of 3 kilocycles; or of two channels of broadcast quality, each with a bandwidth of 6 kilocycles. Alternatively, each side-band can be used to accommodate several voice-frequency telegraph channels. The receiver offers the advantages of improved signal-to-noise ratio; freedom from the non-linear distortion which occurs when normal receivers are subjected to selective fading conditions; and as a high degree of flexibility, as does normal single side-band operation, with the added advantage of increased traffic-handling capacity. Other features are a high order of oscillator stability and freedom from cross modulation which might give rise to cross talk between channels or intermodulation between wanted and unwanted signals. Either the upper or lower side-band can be selected for de-modulation.

The new receiver covers the 4 to 30 megacycle band in three ranges, namely, 4 to 10, 10 to 20 and 20 to 30 megacycles. It is suitable either for normal double side-band operation; for single side-band working with a pilot carrier, the carrier level being 16 decibels below the peak side-band power; and for independent side-band working with a pilot carrier, the carrier level being 26 decibels below the peak power of either side-band. It is of the double superheterodyne type with intermediate frequencies of 3·1 megacycles and 100 kilocycles. The first oscillator can be used with crystal control to provide a choice of nine spot frequencies, or as a high-stability variable oscillator with good short-term stability and freedom from microphony. The second oscillator is self-excited and operates at a nominal frequency of 3 megacycles. It has an audio frequency controlled motor-operated tuning capacitor, covering a range of $\pm$ 4 kilocycles, which is operative even during deep fades. A fine-tuning control, with a slow-motion drive, covers an additional frequency range of $\pm$ 4 kilocycles.

The output from the second intermediate frequency amplifier is applied through hybrid transformers to upper and low side-band and carrier filters. These filters incorporate X-cut crystals, so that temperature variations equally affect them and the third oscillator, the result being that no relative displacement occurs. Each side-band filter is preceded by an attenuator so that side-band levels up to 4 decibels above or 16 decibels below normal can be corrected to give normal level at the demodulator. Forward-acting automatic gain control is applied to the second amplifier valve to compensate for the rise of side-band level of about 6 decibels, which occurs after the normal automatic gain control has operated on the radio-frequency units. Balanced diode demodulators, which are fed from a single hybrid transformer, are employed in both channels, the audio-frequency output being almost independent of the carrier level. The 100-kilocycle local-carrier third oscillator uses a Pierce circuit.

The equipment is mounted in a standard rack and cabinet with doors at both sides and at the back, the height being 7 ft., the width 24 in. and the depth 26 in. It is designed for connection to a 200 to 250-volt single phase circuit, the power consumption being 250 volt-amperes. The output is variable up to + 14 decibels relative to one milliwatt into 600 ohms. The noise factor is better than 7 decibels over the band and the signal-to-noise ratio is 25 decibels for 4 microvolts peak side-band input over the band. As regards selectivity, the response is flat within two decibels for side-band frequencies between 100 and 6,000 cycles. At 10 kilocycles from the carrier frequency it is — 60 decibels relative to the pass-band. The audio-frequency control system operates effectively with a carrier level of — 26 decibels relative to one microvolt, which corresponds to a peak side-band level of one microvolt and a signal-noise ratio of 15 decibels.

LABOUR NOTES.

CLAIMS that the minimum wage rates for women employed in engineering workshops should be raised to the level of adult male employees in the industry were presented to the Engineering and Allied Employers' National Federation on July 29. The case in support of the women's claims was stated by Mr. J. R. Scott, of the Amalgamated Engineering Union, on behalf of his own union and of the Electrical Trades Union, the National Union of General and Municipal Workers, the Transport and General Workers' Union, and the Foundry Workers' Union. In all, some 500,000 women engineering employees are stated to be represented by these five unions, but no figures are available generally to show how many of these operatives are paid only the minimum rate.

At present, the minimum rate for women in the industry is 4*l.* 11*s.* 6*d.* a week, and compares with 5*l.* 18*s.* 4*d.* a week paid to adult male employees, a difference of 1*l.* 6*s.* 10*d.* The employers already have before them a claim from the unions with respect to the men, asking for an increase of 15 per cent. on existing rates, and, if the women's demand for parity is conceded, any increase granted to male employees would automatically be payable to women operatives, in addition to the 1*l.* 6*s.* 10*d.* mentioned above. The women's claim, therefore, represents a demand for a very substantial increase, and indicates, by its size, the earnest desire of the unions to secure the rate for the job for all engaged in engineering work. There have been complaints recently by both men and women unionists, that every time an increase is granted, the women received a little less than the men. The employers promised to consider the claim and give their reply later.

A further claim for a 15 per cent. wage increase was put forward on July 30. On this occasion, the demand was presented to the Railway Executive by the Confederation of Shipbuilding and Engineering Unions and the National Union of Railwaymen, on behalf of operatives in the railway workshops. Some 135,000 railway shopmen are affected by this demand, the terms of which are, in the main, in line with the claims recently presented by the three principal railway unions in favour of the 500,000 railway operating staffs. As in the case of the previous claims, the Railway Executive promised to give the men's case careful consideration and to communicate their decision to the unions in due course.

Some increases in pay to certain classes of civil servants have been granted as the result of awards by the Civil Service Arbitration Tribunal, announced on July 31. These include advances of up to 150*l.* a year to examining officers employed at the Patent Office, of whom 337 are affected, and increases of from 45*l.* to 100*l.* a year for labour managers at atomic-energy research stations, Royal Ordnance Factories, and similar Government establishments, of whom 114 are expected to benefit. The case for a claim on behalf of some 10,000 employees of the London County Council was presented by the L.C.C. Staff Association to the Industrial Court on July 30.

Some disappointment will inevitably be caused by the decision of Earl De La Warr, the Postmaster-General, to withhold recognition from two small staff associations in his Department. He announced in the House of Lords, on July 30, that he had deferred any immediate decision on the report of the Terrington Committee, in the hope that it might be possible to bring together recognised and unrecognised unions in the Post Office. This committee, it may be recalled, recommended the abolition of the formula under which consideration was promised to associations in the Post Office having a membership of at least 40 per cent. of the organised staff in the section or grade concerned. The committee, of which Lord Terrington was the chairman, condemned the formula as an encouragement to secessionist groups desiring to break away from established trade unions.

Conciliation, Earl De La Warr stated, was attempted between the Engineering Officers (Telecommunications) Association and the Post Office Engineering Union, which was the recognised body. Advice had also been received from the Terrington Committee to the effect that the Association should not be accepted officially as a trade union, on the ground that the interests of the staff whom the Association claimed to represent were already fully safeguarded. The other body, the National Association of Postal and Telegraph Officers, with a membership of only 2,600, claimed to represent a grade of the postal service with 21,900 employees. The other officers employed in the grade were members of the Union of Post Office Workers, and that body had been ready to facilitate a friendly settlement by amending its rules. On these figures, the National Association did not qualify even for consideration. Earl De La Warr stated that, in the circumstances, he was unable to grant recognition to either Association.

Another small staff union, the National Guild of Motor Engineers, had agreed to amalgamate with the Post Office Engineering Union on terms which gave the motor-transport staff a greater share in the union's affairs. Two other organisations, the National Association of Telephone Supervising Officers and the Association of Controlling officers, had agreed to the appointment of Sir Richard Lloyd-Roberts as conciliator, and, Earl De La Warr concluded, a report from Sir Richard was now under consideration. The disappointment likely to be caused by Earl De La Warr's decision in the case of the Engineering Officers (Telecommunications) Association may be measured by the fact that over 40 Conservative Members of Parliament had put their names to a motion urging the Postmaster-General to grant the Association's claim.

Wage increases granted to United Kingdom employees during the first six months of the current year were substantially lower than during the corresponding period of 1952. Altogether, some 4,040,000 workpeople, about one-fifth of the country's total working population, received net increases in their full-time wages totalling 1,222,600*l.* a week, an average of about 6*s.* 6*d.* each. During the six months, January to June, 1952, according to the *Ministry of Labour Gazette* for July, 5,046,000 workpeople received net increases in their full-time wages amounting to 2,014,000*l.* This represented an increase of nearly 8*s.* a head. During the first half of this year, 1,113,000 persons in the building and contracting industries received weekly increases aggregating 389,500*l.* net; in the mining and quarrying industries, 445,500 persons received advances amounting to 124,600*l.*; and, in the metal-manufacturing industry, 179,000 persons obtained advances amounting to 13,100*l.* In the engineering, shipbuilding and electrical-goods group of industries, only some 17,500 operatives benefited during the period. Their increases came to a total of 4,200*l.* a week.

There were advances during the half year ended June, 1953, in each of the four categories into which the index of rates of wages is divided. At the end of the period, the index stood at a level of 135 for all employees, and at 134, 139 and 145, for the men, women, and juvenile classes, respectively. These figures compared with 134 for all employees, and with 132, 138, and 143, for the men, women, and juvenile classes, respectively, at the end of December, 1952.

Industrial disputes occurring during the first six months of the present year were both fewer in number and less severe in their effects than those which took place during the corresponding period of last year. There were 858 stoppages during the six months ended June, 1953, and, in them, some 142,300 employees were involved and 647,000 working days were lost. The comparative figures for the six months ended June, 1952, were 908 stoppages, with 214,500 employees involved and more than 897,000 working days lost. During each of these periods, the coal-mining industry was responsible for most of the disputes which occurred.

HYDRAULIC COPYING ATTACHMENT.

HAYES ENGINEERS (LEEDS), LIMITED, LEEDS.

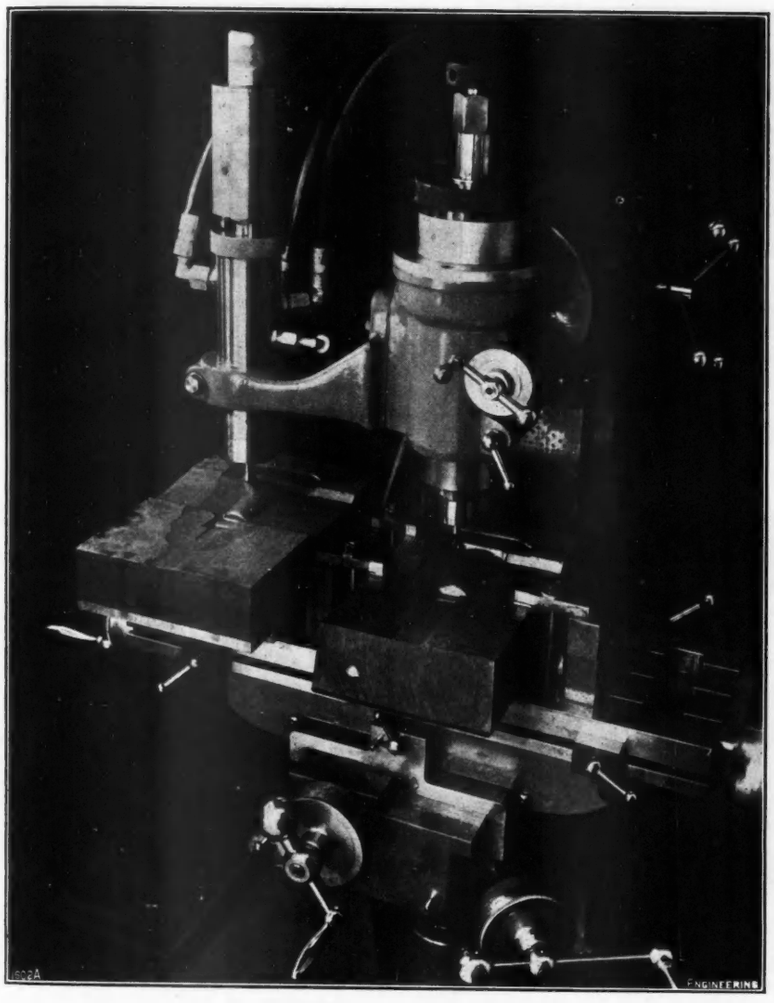


FIG. 1. DIE-FORMING ON MILLING MACHINE.

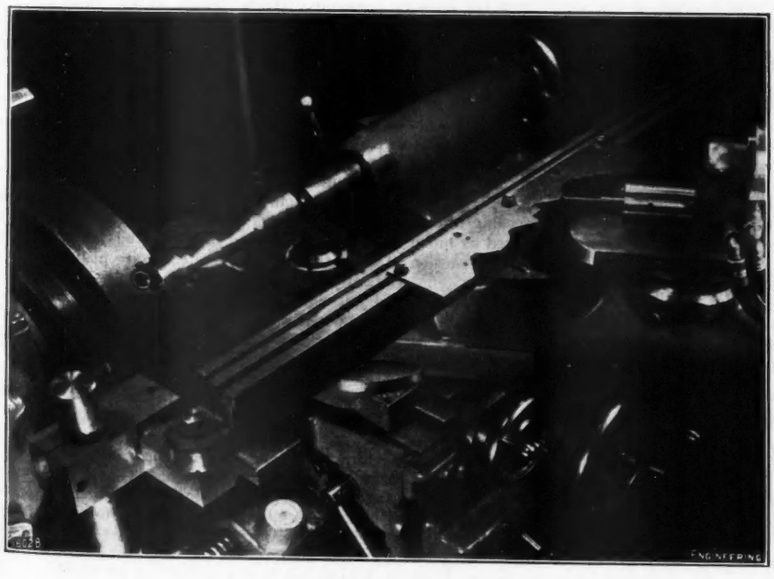


FIG. 2. PROFILE TURNING.

HYDRAULIC COPYING ATTACHMENT.

THE hydraulic copying attachment shown in the accompanying illustrations has been designed for converting existing machine tools, which are of a sufficiently high standard, into profile-copying machines. It can be fitted to existing designs of lathes, milling machines, vertical or horizontal boring machines or any other type of machine for which the copying method is appropriate. The attachment is suitable for reproduction from either models or templates and by its use the forming of dies and the turning of cams has proved to be an economical operation. The attachment, known as the Hydrotracer, is made by Hayes Engineers (Leeds), Limited, Gelderd-road, Leeds, 12.

The Hydrotracer consists of a tracing head connected to a hydraulic cylinder, both of which are connected to, and operated by, a self-contained motor-driven hydraulic pump, fitted with a filter and re-circulating tank. The complete equipment, fitted to a milling machine is shown in Fig. 1, in which the tracing head is being used for die forming. Fig. 2 shows the attachment being used for profile turning. The stylus pressure can be varied between 8 oz. and a few pounds, and the oil pressures for the working head can be varied between 50 lb. and 1,500 lb. per square inch. An adequate operating capacity is available that will suit any normal machine-tool requirements.

The Hydrotracer embodies a patented system of hydraulic control which, it is claimed, gives a much quicker response to changes in profile. Built into the tracing head is a composite valve which not only follows variations in controur but eliminates static friction throughout the whole hydraulic system by employing a pulsatory oscillation superimposed on the mean oil pressure. These pulsations, of a micro amplitude, have a frequency of 1,500 impulses per minute and the net effect is a significant reduction in the time lag in the reversal of the cutting-tool movement. The self-contained power unit includes an electrically driven pump, of the submerged type, fitted with pressure-control valves, a pressure gauge and a filter unit, all mounted in a tank designed to stand at the side of the converted machine. Consequently, no special oil containers need be provided when a machine is to be adapted for copying. The modifications required to the machine consist primarily of the attachment of the control cylinder to a convenient member of the machine frame, and of the tracer head to the cutter head by means of a bracket. The tracer can be quickly detached so that the machine can be used for its normal work.

The standard tracing head has a follower with a universal stylus movement, but units are available in which the movement is restricted to, for example, a vertical movement only or a vertical movement with a swivelling movement in one direction only. The standard profile attachment is suitable for medium-sized lathes but special attachments are made for machines outside the range of the standard model. For traverse turning, the copying slide can be set at right-angles to the lathe bed and at any angle up to nearly 60 deg. from the line of the tailstock, and up to about 45 deg. from the line of the headstock. For profile turning, the copying slide may be set parallel to the lathe bed or up to 60 deg. in either direction from the mid-position. A feature of the attachment is that the separate slide carrying the tracer valve may be set at any angle independently of the main profiling slide, making it possible to use a direct-reading dial gauge for checking the dimensions after the final cut.

It is claimed that accurate reproduction is maintained to within a tolerance of 0·0002 in. under normal working conditions. Recent developments are such that the normal milling-machine spindle and quill can be replaced by a high-speed spindle driven by an air turbine. Operating in the region of 40,000 to 60,000 revolutions per minute, and using precision-ground carbide burrs, the high-speed spindle is intended for the finishing of dies and moulds. The finish obtained is claimed to be practically free from cutter marks and the workpiece is then ready for hand polishing.

RE-ORGANISATION OF DIE-CASTING FOUNDRY.

NON-FERROUS DIE CASTING CO., LTD., LONDON.

Fig. 1. Interior of Foundry.

Fig. 2. Low-Pressure Die-Casting Furnace.

Fig. 3. Fettling Shop.

Fig. 4. Inspection Department.

RE-ORGANISATION OF DIE-CASTING FOUNDRY.

Gravity die-casting or permanent-mould casting, as it is known in the United States, has been used in this country for the past 38 years and the Non-Ferrous Die Casting Company, Limited, Nonferdica Works, North Circular-road, have been engaged in the development and application of the process since 1923. During the past three years, they have been replanning and extending their works. The extensions are now nearly completed and, as a result, their production capacity will be increased from 60 tons of finished castings per month to 100 tons. The business of the firm is primarily the production of brass, bronze and aluminium castings by the gravity-feed method, but a small section of the plant is employed on low-pressure aluminium casting; this section also is to be enlarged. The castings produced range from a few ounces up to 15 lb. in weight. The limits that can be obtained on castings of this nature are said to be within $\pm 0{\cdot}005$ in., but this may vary with the shape and size of the casting.

The new extensions to the Non-Ferrous Die-Casting Company's works include a two-storey building containing on the ground floor a fettling shop, an inspection department and a despatch department, together with additional office accommodation. A sub-basement houses the canteen, the maintenance department and the general stores. Behind the original works, the furnace-maintenance department and laboratory have also been replaced by new and enlarged buildings. The die-making department is being enlarged and equipped with new machinery, and the extensions to the foundry now cover more than double the floor-space previously occupied.

The die store, which is a three-storey building, contains over 4,000 dies, all of which are maintained ready for use at any time. Formerly, when the dies were returned to the stores from the foundry, they were placed in their appropriate racks and left there; it was found, however, that considerable oxidation occurred on the faces of the dies and on the cores, so that considerable time had to be spent in cleaning before a die could be used again. To prevent this, a grease-coating plant has been installed. After use, the dies are now cleaned and immersed in a vat containing a grease compound which prevents corrosion while the dies are in store. When the die is required to make a further batch of castings, it is cleaned in a degreasing tank. In some cases, it is stated, this has saved as much as two days labour in the cleaning and inspection of a die.

The new foundry is to be equipped with 54 furnaces; a section of it is illustrated in Fig. 1, herewith. The furnaces used are in two sizes, with capacities of 300 lb. and 900 lb. for brass, and 150 lb. and 300 lb. for aluminium. They are gas-fired and are placed in pairs to simplify the layout of the extraction equipment which is used to exhaust the fumes from the area round the operators. Beside each furnace is a bench and a circular tank containing the water and graphite compound which is used as a die lubricant and dressing. The graphite and water are continuously agitated by a small flow of air, which is bled from the overhead air-line, and injected into the base of the tank. At present, there are also six low-pressure die-casting furnaces in use in the foundry. One of these is illustrated in Fig. 2. It comprises a furnace case containing an iron crucible. The crucible is sealed by a top cover-plate having a feed extension on the underside which, when the cover is in position, extends downward to within 2 in. of the bottom of the crucible. When bolted down, the cover-plate, which is fitted with an asbestos sealing washer, will withstand an internal pressure of 8 lb. to 10 lb. per sq. in. A fixture holds the die in position above the cover-plate. The molten metal is forced from the crucible up the feed extension on the cover-plate into the die by compressed air pressure, admitted above the surface of the metal. The pressure is held for a few moments and then released, the die opened and the casting removed. This process is only used for the production of aluminium castings and is claimed to give an improved finish and accuracy, and to reduce the risk of blow holes.

Both dies and steel cores are made by the company in their tool room, usually to tolerances of $\pm 0{\cdot}0005$ in. In some cases the interior shape of a proposed casting requires the use of a sand-core in place of a collapsible steel core, and the necessary equipment is provided for making them. The castings pass from the foundry to the inspection department, and thence to the fettling shop for the runners and sprues to be removed and for the final dressing. This department is equipped with a number of band saws, milling machines and abrasive-wheel cutting-off machines. The final cleaning is carried out on the benches by filing and grinding, after which, before being dispatched, the castings are again inspected.

The compressed air used throughout the plant is supplied from a battery of six Broom and Wade "N" type compressors—five normally working and

the sixth as a stand-by unit—which feed into a common main. A plant for the recovery of brass and bronze from the dross has been installed. It was designed and made with the assistance of the Sturtevant Engineering Company, Limited, and recovers about 30 per cent. by weight of metal from the charge. The dross passes through a series of rollers which flatten the particles of metal present and increase their surface area. The particles are then distributed over a number of revolving sieves with varying grades of mesh, which extract the metal from the dust.

The metals normally used in the foundry accord with the requirements of the British Standard Specifications and include in the copper base range, B.S.S. 1400: B4-C, B5-C, AB1-C, AB2-C. In one instance, however, a free-cutting brass was needed which could be readily die-cast. To obtain this involved much experimental work, as a result of which they now produce castings in a brass alloy containing a small lead content, which, it is claimed, possesses the required machining properties. The demand that has developed for this material led the company to submit details of its composition to the British Standards Institution with a view to its inclusion in the new British Standards list.

LAUNCHES AND TRIAL TRIPS.

S.S. "SAXONMEAD."—Single-screw oil tanker, built and engined by Vickers-Armstrongs Ltd., Walker-on-Tyne, for the Imperial Shipping Investment Co., Ltd. (Mr. Stavros S. Niarchos), Bermuda. Main dimensions: 528 ft. between perpendiculars by 75 ft. by 40 ft.; deadweight capacity, about 20,000 tons on a draught of 30 ft. 6 in.; gross tonnage, 13,320. Parsons type double-reduction geared steam turbines, developing 8,300 s.h.p., and two Babcock and Wilcox boilers. Speed, 14½ knots, fully loaded. Launch, June 25.

M.S. "MERCHANT BARON."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Drake Shipping Co., Ltd. (Managers: Lykiardopulo & Co., Ltd.), London, E.C.3. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in.; deadweight capacity about 18,000 tons on a draught of 30 ft. 6 in.; oil-carrying capacity, 17,288 tons. N.E.M.-Doxford six-cylinder two-stroke opposed-piston oil engine, developing 6,800 b.h.p. at 119 r.p.m., constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, about 15 knots. Trial trip, July 20.

M.S. "ADRASTUS."—Single-screw passenger and cargo vessel, built by Vickers-Armstrongs Ltd., Walker-on-Tyne, to the order of Alfred Holt & Co. for the Ocean Steam Ship Co., Ltd., Liverpool. Ninth post-war vessel for these owners. Main dimensions: 487 ft. overall by 62 ft. by 35 ft. 3 in.; deadweight capacity, about 9,000 tons on a draught of 28 ft.; gross tonnage, 7,800. Harland-B. and W. seven-cylinder Diesel engine, developing 7,000-7,600 b.h.p., constructed by Harland and Wolff, Ltd., Belfast, and installed by the shipbuilders. Service speed, 15½ knots. Launch, July 22.

M.S. "BRITISH FLAG."—Single-screw oil tanker, built and engined by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne, County Durham, for the British Tanker Co., Ltd., London, E.C.2. Main dimensions: 547 ft. overall by 69 ft. 6 in. by 37 ft. 6 in. to upper deck; deadweight capacity, about 16,200 tons. Hawthorn-Doxford six-cylinder combined-stroke opposed-piston oil engine, developing 6,400 b.h.p. at 115 r.p.m. Trial trip, July 22 and 23.

M.S. "BALTISTAN."—Single-screw cargo liner, with accommodation for five passengers, built by John Readhead & Sons, Ltd., South Shields, for the Strick Line, Ltd. (Managers: Frank C. Strick & Co., Ltd.), London, E.C.3. Main dimensions: 450 ft. between perpendiculars by 58 ft. 6 in. by 32 ft. 2 in. to upper deck; deadweight capacity, 9,750 tons on a draught of 25 ft. 8 in. N.E.M.-Doxford four-cylinder opposed-piston oil engine, developing 4,400 b.h.p. at 115 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, about 13 knots. Trial trip, July 23.

S.S. "BRITISH MERCHANT."—Single-screw oil tanker, built by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, for the British Tanker Co., Ltd., London, E.C.2. Main dimensions: 630 ft. between perpendiculars by 85 ft. 6 in. by 46 ft. 6 in. to upper deck; deadweight capacity, about 32,000 tons on a draught of 35 ft.; oil-carrying capacity, about 1,500,000 cub. ft.; gross tonnage, 21,000. Double-helical geared steam turbines, developing a maximum of 13,750 s.h.p. at 116 r.p.m., and two Babcock and Wilcox oil-burning boilers. Turbines and boilers constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Service speed, fully loaded, 14½ knots. Launch, July 24.

BRITTLE FRACTURE STUDIES IN THE UNITED STATES.*

By S. L. HOYT.

BRITTLE fracture has been with us for many years; in fact, since the first large-scale use of Bessemer and open-hearth steel. In the *Journal of the Iron and Steel Institute* for 1875, the "uncertainties and treacheries of Bessemer steel" were deplored, and in 1879 it was noted that Bessemer angle bars were very sensitive at times to "some trifling blow," especially "during the late severe weather at Chatham." No explanation was forthcoming, though Percy, in 1864, had stated that nitrogen affects steel. In 1880 it was recognised that brittleness increases at low temperatures, depending on the amounts of C, Si, and P, and one man had the vision to see that the tension test does not tell the whole story of steel quality. In 1882, we find studies of the effects of strain and notches, and a true stress-strain diagram was determined for steel up to failure. In 1887, Allan reviewed brittle fracture of homogeneous steel and mentioned the complete fracture of a steel plate at the Forth Bridge works "some time ago," when it was bent cold. The author has also been told that Bessemer steel destined for the Brooklyn Bridge shattered when accidentally dropped. In 1890, a very enlightening comment was made on rupture strength and the effect of a notch. The notch increases the resistance to shear flow but not to rupture, while the yield strength depends on the section at 45 deg. to the load, not at 90 deg. Nearly half a century later, the present author used that concept in analysing the notch effect, but was unaware at the time by how much he was antedated. The improvement of low-temperature toughness which is produced by heat treatment was likewise recognised at that time. In 1894, a little item expressed surprise that impact produces greater ductility than static loading does, though that statement needs amplification.

These experiences were repeated in other countries, and at about the turn of the century it was decided to do something about it. Aside from the effects of the external variables, temperature, strain, and impact, the presence of a notch was held to be mainly responsible for the "mysterious" brittle failure of normally ductile steel. It was then that the Izod test was introduced in Great Britain, and the Charpy test in France and in other European countries. Incidentally, it had been shown many years previously, with glass models and polarised light, that an applied stress concentrates at a notch. These notched-bar tests have helped in combating the faulty application of steel and have had a healthy influence on design. However, it is only very recently that this problem of brittle fracture has developed widespread interest.

When the Schenectady broke in two at her pier at Portland, Oregon, one wintry day in 1943, the event first attracted serious attention to the phenomenon of brittle fracture, though it was reminiscent of the brittle bridge over the Albert Canal, Belgium, and even of the Bessemer angle bars that broke "during the late severe weather at Chatham." As is usual in such instances, tests were run on the steel to see if it was up to standard; they showed that the steel met all the requirements of the specifications. This would have left the failure in the "mysterious" category, but, fortunately, there came the significant additional finding of an independent investigator (Professor Graff) that the steel was notch-brittle when tested at the temperature of the air at the time of failure. Some questionable features of design were also observed, which were corrected in later ships.

As a result of the failure of the Schenectady and of other welded ships, and after "locked-up stresses" were dismissed as a primary cause of failure, the significance of the notch toughness of ship steel was finally recognised and a large-scale study of brittle fracture was started. Prior to that time, it was customary to investigate failures by means of the conventional tests, such as tension, bending, chemical, microscopical, etc. Following this mishap, however, the investigational work was conducted with the full understanding that the tests must include the stress concentrations and multi-axial stresses of the structure, and must reproduce the brittle fractures of service. These studies included full-sized test specimens and large full-thickness plates, along with small laboratory specimens. This may truly be said to mark a milestone in the engineer's appreciation of the significance of local stresses in his structures, though that other countries had previously conducted such investigations as a result of somewhat similar experiences.

It is the author's particular object to comment on some of this work which is being done in the United States on steel—that is, excluding engineering tests of steel structures—but he wishes to emphasise that the fact of brittle fracture in service does not necessarily imply that the remedy is the substitution of a steel with a higher level of notch toughness. The proper remedy, barring faulty workmanship or inspection, may be a modification of design to produce a better streamline flow of stress; or it might be the use of some device to relieve rigidity and to arrest any fractures that might start. If there was nothing but notch-sensitive steel, it is fair to say that engineers would use stress flow and flexibility as two of their major guides in design and, even in present circumstances, it is well that they should incorporate these principles as far as is practicable.

Work on brittle fracture can conveniently be divided into studies of the basic principles or the cause and mechanism of the fracture process; tests of steel, including the effects of welding; and studies of the effects of steel-making practice, including composition. These three phases are being studied simultaneously and are brought to convergence on the main problem through publications and group meetings of those who are interested.

BASIC PRINCIPLES.

A discussion of the basic principles of brittle fracture may well be initiated by a quotation from a recent paper of G. M. Boyd*—"It appears unlikely that the interpretation of notch tests will be clarified by the mere accumulation and analysis of results. Ultimately, such clarification can only be the result of a better understanding of the mechanics of fracture generally." This viewpoint is not to be seriously questioned and some of the most promising work being done is aimed in this direction. From the tension test, it appears that the yield stress, or the maximum shear stress which initiates plastic flow, is essentially the same in notch-brittle and notch-tough steels of the same grade and analysis. According to Ludwik's ideas on the effect produced by a notch, the notch-brittle condition must result from a significantly lower cohesive strength† of the undeformed metal, as compared to the notch-tough condition. In other words, the notch-tough steel is able to support the normal or cleavage stress until the shear stress overcomes the shear resistance and ductile flow ensues; the notch-brittle steel cannot do so and fails by simple cleavage (brittle fracture) before deformation sets in. In both cases, the steel has a functional slip mechanism. This situation holds regardless of the build-up of energy as the stress is increased to the point of initiation of either fracture or deformation. In brittle fracture, the propagation depends on the amount of energy that is available and the amount required to separate the surfaces, provided it is at a sufficiently high stress level to overcome the cohesive strength. In this light, the initiation of brittle fracture depends on the cohesive strength and the shear strength, and the propagation depends on the cohesive strength and energy of separation. These properties, in turn, are controlled by composition and structure.

* Paper presented at the Conference on Brittle Fractures in Steel, organised by the West of Scotland Iron and Steel Institute and held in Glasgow on May 15, 1953. Abridged.

* "The Assessment of Notch Ductility by a Variety of Notch Tests." Symposium on Notch Bar Testing and Its Relation to Welding, 1953. London: The Institute of Welding.

† The term "cohesive strength" as used here is intended to mean the "technical cohesive strength," as distinguished from the theoretical lattice strength.

Two principal approaches are being used, which are studies of single crystals of iron and studies of high-purity iron and alloy ferrites. With the knowledge of the mechanics of the notch effect, it is to be hoped that these studies will so illuminate the effects of these two variables that the designer can design for cohesive strength to guard against brittle fracture in the way that he now handles the simpler stresses.

Tests of steel, and tests of tests of steel, are being conducted by a number of workers. This activity includes welding and its effects, and the aim is that of learning more about the steels now being produced and what harmful effects welding may have, if any. Among the questions that appear to be important are: Is a test of the steel adequate or should welding be included ?; What test specimen should be used ?; What is the significance of impact or rate of loading ?; What is the significance of the test temperature and the transition temperature ?; What is the utility of weldability tests ?; What role should size and design play in tests for brittle fracture ? This work is being handled by the Welding Research Council, the Ship Structure Committee, various agencies of the United States Government, and numerous private interests. It is only fair to state that, at this early stage of the development of the subject matter, divergent views are held on a number of these points and need clarification.

Welding was first used in connection with tests of steel for welded structures in Germany, as the weld-bead test. The test bar may break in brittle fashion under conditions that produce bending in a similar test bar of the stock proper. It was observed that different steels responded differently in this test and, on the face of it, it appeared that the test differentiated between steels of different weldabilities. In the United States, the test is performed with a transverse notch (notch-weld-bead-bend test) which cuts through the stock, the heat-affected zone, and the weld bead. However, some columnar weld metal remains at the bottom of the notch and needs to be seriously considered when interpreting the test results.

Tests of samples with a weld bead on one face show that some steels of a given quality are more prone to break with a brittle fracture than others are. The crux of the matter is this—Is it because one steel has been harmed more by welding and is less "weldable" than the other, or is it because that steel is more notch-brittle ? In studies at the Battelle Memorial Institute with the notched specimen, it was found with ship steel that the fracture initiated in the columnar weld metal and produced a new notch which then spread through the heat-affected zone and the stock proper. It was the weld-metal crack that opened up, and not the machined notch that initiated the fracture and dominated its propagation. The heat effects of welding had little or no influence when the carbon was less than about 0·3 per cent. The early German work, and tests made by Parker of the University of California and by the Battelle Memorial Institute, showed the same behaviour in the absence of the machined notch. In the light of this behaviour, it is clear that we were testing the resistance of the stock to the spreading of the weld-metal crack; any differences that showed up were due to differences in notch brittleness of the steels, and not to differences in weldability. Obviously, these mild steels are all weldable, in the ordinary sense, but they do respond differently to the effect of the weld-metal crack. If the steel is higher in carbon and has greater hardenability than ship steel, the crack may first form in the heat-affected zone. This indicates a lower degree of weldability, and such a steel would usually be welded under conditions which avoid that hard zone. It does not appear to have been demonstrated that such a hard zone, if crack-free, has been responsible for service failures.

In addition to laboratory tests of structural steel, studies of failed structures also throw light on the question of weldability *versus* notch brittleness in the problem of brittle fracture. The principal investigation of this type is that of the National Bureau of Standards on the notch toughness of samples of steel from fractured merchant ships. They classify the plates as those in which the fracture started, those through which the fracture propagated, and those in which it stopped. With the Charpy V or Izod notched-bar and the 15 ft.-lb. criterion, it was found that the transition temperature of the plates in which the fracture stopped was lower than that of those in which the fracture started. When the test data were examined statistically, this difference was shown to be significant.

The evidence to date provides a valuable guide to the testing of steel for service of this nature. Thus, while there is a lack of precise evidence on the initiation of the fracture, it is a matter of record that the fracture, after it has once started, passes through the plates and sections proper, and not along a path that has been influenced by welding. The function of welding is to produce a monolithic structure, which makes possible the transmission of stresses and the storage of energy throughout the ship. Thus the mechanism of failure of welded test specimens and the evidence of ship fractures both point to tests of the steel proper as the procedure to use when no question of under-bead hardening or cracking is involved.

The next question concerns the test specimen to use. The only logical answer is the general one—use the specimen that correlates best with service experience; though the author would add that the correlation should hold for the service temperature at which failure occurs. In the United States there are two general types of small or laboratory specimens: the Charpy bar with either keyhole or the V-notch, and the Navy or Kahn tear test, which uses the whole plate thickness and causes the specimen to fail in the same direction as it does in service. An associated question is that of the criterion to use in judging the results of the test. That is still controversial, and different investigators use breaking strength, ductility, energy absorption, fracture appearance, and transition temperature, according to their choice. Certain A.S.T.M. specifications require 15 ft.-lb. in the Charpy impact test at the lowest service temperature.

Turning to the problem of selecting the test specimen: at one time the author had occasion to examine a forging, the failure of which had caused terrific damage. The usual tests failed to show that there was anything wrong with that forging, or even anything unusual about it. They included microstructure and chemical analysis, and even the Charpy test showed the usual value of about 20 ft.-lb. At the same time, the author was also studying the effect of the width of the Charpy bar on its performance, and had found that, in most instances, a double-width bar absorbed about twice as much energy as the standard bar. However, there were times when it absorbed less energy, and, from this and from the failure of the Izod and Charpy bars always to correlate, he had reason to suspect that some steels would exhibit abnormal behaviour under the more severe stress conditions of the double-width bar. Subsequently, that failed forging was tested, and it was discovered that it ran less than 10 ft.-lb. in the double-width bar. That gave the first and only clue that something was out of line, and is represented by steel A in Table I, herewith. The same was also found to be true for about eight other forgings that had failed for reasons which were not understood at the time. The standard value for that steel in production runs was about 40 ft.-lb. and is represented by steel B. In this instance, it was the double-width Charpy bar, tested at room temperature, that best represented the service conditions, and the various other tests were of no avail in screening out inadequate forgings.

It could be argued that, had the standard Charpy bar been tested at temperatures below the operating temperature to determine the transition temperature, it would have been found that the failed forgings would have "become brittle" at higher temperatures than the good forgings did. It is known that such might have been true, but the author was concerned with the properties of the steel at its service temperature and not with the way those properties might have changed at lower temperatures. This bears on the geometry of the test bar to use for correlation with service. In the example cited, it was the double-width bar rather than the single-width bar that correlated best with service, though in other instances it might be the standard Charpy bar or the Izod bar, or some other. In the present state of uncertainty, the correlation should be determined for each application as best may be done.

The philosophy of the testing of the failed forgings, just discussed, as applied to the welded-ship problem, would suggest the determination of the severity and type of the notch conditions required in the test bar to produce brittle fracture in the steel at the temperature at which it failed in service. A second point is the desirability of studying steels that have gone through similar service, but without failure. At present, it is not known what level of notch toughness is needed for satisfactory service, and it is quite uncertain just how to appraise the results of tests which are limited to material that has failed.

The effects of test temperature and rate of straining are best considered in relation to each other. On the basis of Ludwik's hypothesis, the only definitive stress condition in the notched bar is that during elastic deformation, which, we will say, is calculable on the basis of Neuber's work. That is true whether the bar breaks at the elastic limit (brittle fracture) or subsequently deforms plastically. This is also the only condition for which the stresses in the test specimen can be evaluated as strength properties. The significant stresses here are the normal stress at the root of the notch and the maximum shear stress. The strength properties are the cohesive strength which supports the normal stress and the shear strength (elastic limit or yield strength) which supports the shear stress.

Assuming first that the bar breaks at the elastic limit, it is known by definition that the cohesive strength was reached. Ignoring the complexity of the cohesive strength, it can be said that the normal stress at the moment of fracture was equal to the cohesive strength. The shear strength can be determined from the tension test. The author has called this point of brittle fracture the "match point," because it gives the conditions of test-bar geometry and material properties at which the stresses match the strength properties. In other words, at this point the ratio of the normal stress to the maximum shear stress equals or matches the ratio of the cohesive strength to the shear strength. This match point comes at the heel of the transition-temperature curve. If, on the other hand, the bar deforms, it is known that the cohesive strength was sufficiently high to hold it together while the shear stress produced the deformation. However, in this event we cannot know how much higher than that the cohesive strength lay. Furthermore, plastic deformation changes the geometry and the stress pattern of the bar, and also modifies the steel properties by strain-hardening and ageing. While it is known that the steel responded in ductile fashion, and while the energy absorption gives a measure of the notch toughness under the test conditions, there is no way of interpreting the stress-strain relationship in terms of the basic properties of the steel in its initial or undeformed condition. Since brittle fracture in service occurs in essentially undeformed metal, it is a corollary that tests resulting in deformation do not bear directly on steel properties in the service conditions which led to failure.

(To be continued.)

TABLE I.

Steel.	Elastic Limit, Lb. per Sq. In.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 in., Per cent.	Reduction of Area, Per cent.	Charpy Test.	
					Single Width, Ft.-Lb.	Double Width, Ft.-Lb.
A	55,000	91,400	28·5	61·8	19·5	8
B	58,000	96,000	26·5	60·0	19·0	37

VIBRATORY CLASSIFIER.

HOLMAN BROTHERS, LTD., CAMBORNE, CORNWALL.

FIG. 1. GENERAL VIEW OF CLASSIFIER.

Fig. 2.

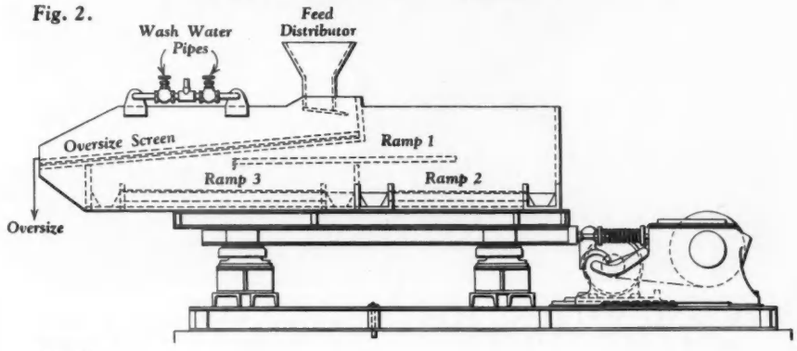
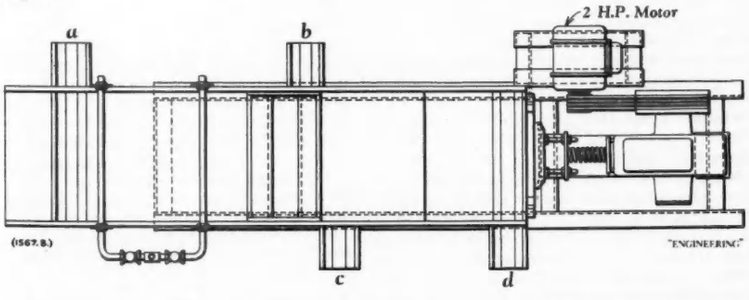


Fig. 3.



VIBRATORY CLASSIFIER.

THE accompanying illustrations show a vibratory classifier made by Holman Brothers, Limited Camborne, Cornwall, and designed for grading mineral ores, sands, clays and coal slurry. When used in conjunction with ore-treatment plants, the classifier serves to select the material for further treatment, so ensuring that only material within given limits of size is delivered to the concentrating tables. It is claimed that satisfactory operation is obtained with widely differing materials, and, in particular, that it is possible to separate washed gravel sand and clay from china-clay waste.

The classifier consists essentially of a series of vibrating ramps. The material is fed from a distributor, indicated in the sectional elevation, Fig. 2, on to an over-size screen which discharges the excessively large material from the end of the classifying box; if it is not required, this over-size screen is easily removed. Under-size material falls through the screen on to ramp No. 1, where the initial classification is made. In this part of the operation, the finer material travels backwards and the coarser forwards until the two grades fall respectively on to ramps Nos. 2 and 3, where further classification takes place. The sorted material is finally discharged from the classifier box, the coarsest material at point *a*, indicated in the plan, Fig. 3, and the finest from point *d*. Material of intermediate sizes is discharged from points *b* and *c*. The vibratory motion for the classifier is obtained from a series of eccentric rockers and springs, the eccentricity of the rockers being regulated to suit the materials being handled. Driving power for the vibrating mechanism is obtained from a 2-h.p. motor and is transmitted by four ½-in. V-belts, to give a speed of between 270 and 280 r.p.m. at the eccentrics.

The overall dimensions of the standard machine are: length, 11 ft. 6 in.; width, 3 ft. 8½ in.; height, 4 ft. 4½ in.; and the weight is 15 cwt. The dimensions of the classifying box are: length, 7 ft. 4 in.; width, 2 ft. 0 in.; and its weight is 1 cwt. Machines can be built in sizes other than these, when the capacity will be proportional to the width of the machine. Typical capacities for the standard machine are between 2½ tons and 2½ tons per hour if china clay is being handled, and about 1½ tons per hour in the case of tin ore.

PORTABLE ELEVATOR FOR BUILDING CONSTRUCTION.

A PORTABLE brick elevator for raising bricks, tiles or similar materials to a height of about 20 ft. is made by Messrs. M. B. Wild and Company, Limited, 50, Pall Mall, London, S.W.1. It can be easily dismantled into two portable sections, each light enough to be carried about a building site by two men, and yet is still capable of dealing with bricks at the rate of 1,500 per hour. The low overall weight of the elevator makes it feasible to mount it on scaffolding, so that it is possible to use two elevators in tandem to raise material to the third and fourth storeys of a building.

The base unit of the elevator comprises an air-cooled petrol engine of 1 h.p., a worm reduction gear unit and a clutch, all built into an angle-and-plate housing. No bolts or pins are required to fit the elevator, at a convenient angle, on to the base, attachment being made by a clip arrangement, which is claimed to be very quick and simple to manipulate. The elevator is of steel box construction with sprockets for the driving chain at each end; a precision roller type of chain is used to carry the steel trays, which are attached to the chain at 4-ft. intervals. The trays are mounted so that they feather automatically when returning, being guided and protected from damage by the lower part of the casing of the elevator. The attachment arrangements between the base unit and the elevator are such that the latter may be operated with the discharge end at all levels between 2 ft. 6 in. and 22 ft. above the loading point; the lower limit permits the elevator to be used, if necessary, as a simple conveyor.

The new elevator described above has been developed from an existing, but heavier, machine produced by the same makers. This earlier machine had a higher capacity for handling bricks, up to 2,500 per hour, but the difficulties of shifting it about a soft site did not justify its use unless a very large number of bricks had to be moved. For this reason, the new elevator has been developed which is of low weight, but has a capacity sufficient for most constructional work.

AMALGAMATION OF INDUSTRIAL ORGANISATIONS ABANDONED.—The merger of the Federation of British Industries and the British Employers' Confederation, which has been under discussion since 1946, is not now to take place. Resolutions accepting the principle of fusion were adopted in December of that year and a joint committee was set up to prepare a scheme acceptable to both organisations. After a thorough examination of the whole matter, the committee have reported that the work of both bodies has increased to such an extent that amalgamation would inevitably result in the administration of the joint organisation becoming very cumbersome. The different character of the problems with which they each have to deal and their varied historical development have contributed to this decision. The committee consider that the interests of British industry will be served best by maintaining in existence two separate organisations, working closely together, but each responsible for handling those matters which come within its own province. The British Employers' Confederation, which transferred its offices in 1945 to the headquarters of the Federation of British Industries at 21, Tothill-street, London, S.W.1, to facilitate the proposed merger, will move shortly to a new address.

COMMONWEALTH CABLE CONFERENCE.

The Commonwealth Conference on Cable Standards was held at the headquarters of the British Standards Institution, London, from July 14 to 22, and was attended by representatives from the national standards organisations of Australia, India, New Zealand, Pakistan and the United Kingdom. The chairman was Mr. P. V. Hunter. The primary object of the Conference was to secure a better understanding of the different points of view held in the Commonwealth countries on standards for rubber-insulated, paper-insulated and P.V.C.-insulated cables, and to endeavour to make recommendations for subsequent consideration by the standards bodies in the Commonwealth, with the object of securing the greatest possible uniformity in future. Some of the more important recommendations are given below.

Rubber-Insulated Cables.—Owing to the differing views expressed regarding the advisability of specifying the composition of rubber insulation, instead of relying entirely on test requirements to assess its quality, it was recommended that all Commonwealth countries should reconsider this matter; and, should they decide in favour of specifying the composition, consideration should be given to the views expressed at the Conference regarding the advantages of a low volumetric limit of rubber content. Consideration should be given to the desirability of specifying separate grades of compound for temperate and in tropical climates.

It was recommended that rubber-insulated cables should be classified into medium-voltage general-purpose cables, and medium-voltage heavy-duty cables as follows:—Medium-voltage general-purpose cables are those which are suitable for use on any system where the voltage to earth does not exceed 400, and on any three-phase system with earthed neutral point in which the voltage between conductors does not exceed 690. Medium-voltage heavy-duty cables are those suitable for operation at 660 volts to earth, and on any three-phase system with earthed neutral point in which the voltage between conductors does not exceed 1,100.

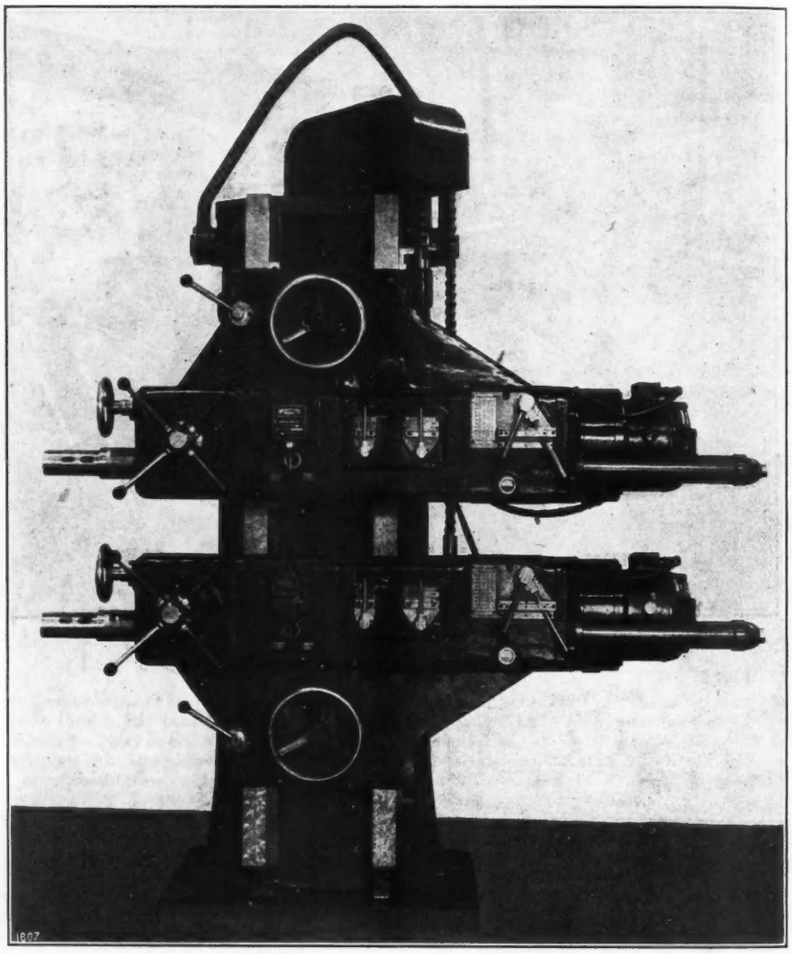
Insulation Thickness.—The Commonwealth standards bodies are to be requested to consider the possibility of adopting thicknesses for the general-purpose medium-voltage cables equal to 85 per cent. of the thicknesses specified in B.S. 7 : 1946 for 250-volt cables, subject to a minimum insulation thickness of 0·030 in. It is recommended that the figures so determined should be specified to the nearest mil (0·001 in.) to provide a more logical system of increasing insulation thickness with conductor size.

Paper-Insulated Cables.—It was proposed that factory lengths of paper-insulated cable should have their ends labelled "A" and "Z," respectively, the "A" end having cores numbered in a clockwise sequence and the "Z" end anti-clockwise. To identify low-voltage (1,100-volt) cables a perforated paper tape is recommended for inclusion over the sheath. The same dimensions of bedding, armouring and serving are recommended for adoption for both rubber-insulated cables and paper-insulated cables, and a recommendation has been made regarding a specification for the compounds used in beddings and servings.

P.V.C.-Insulated Cables.—The Conference proposed that P.V.C.-insulated cables should be classified into medium-voltage general-purpose and medium-voltage heavy-duty grades, as for rubber-insulated cables. It was recommended that the Indian and United Kingdom national committees should consider reducing the dimensions of the single-core unsheathed P.V.C. cable to correspond with the single-core rubber-insulated cable, and that the Australian Committee should consider adopting a range of thicknesses of P.V.C. insulation and sheath on the same basis as for rubber cables. It was recommended that the Commonwealth standards bodies' committees should review the question of either specifying the limit of vinyl chloride content in the polymer, or specifying mechanical tests on the extruded P.V.C. compound. Insulation resistance figures should be based on a resistivity value of 2×10^{13} ohm-cm.

DRILLING MACHINE FOR ARMATURE YOKES.

KITCHEN & WADE, LTD., HALIFAX.



DRILLING MACHINE FOR ARMATURE YOKES.

We illustrate above a drilling machine which has been developed by Messrs. Kitchen and Wade, Limited, Arundel-street, Halifax, Yorkshire, for drilling, from the inside, armature yokes and similar cylindrical components of large diameter. As will be seen, the machine has two drilling heads, which are similar except that they are right-hand and left-hand, respectively. The minimum distance between the spindle centres is 1 ft. 2 in., and the maximum is 3 ft. 4 in. The spindles, which are splined, have a minimum diameter of 2½ in. and are bored No. 5 Morse taper at the nose end. They have a traverse of 30 in. and are supported throughout by a hardened steel sleeve of large diameter. The feed rack on the sleeve is cut from the solid.

Each drilling head is driven by a separate built-in motor of 6 h.p. Nine changes of spindle speed are provided, ranging from 300 down to 30 revolutions per minute. The speeds selected are directly indicated. There are six power feeds, ranging from 60 to 200 cuts per inch; and both rapid and fine adjustments are available. The fine adjustment is by a small handwheel at the side and the rapid adjustment by the cross handles. When the desired setting has been made, the handles are pushed inward to engage the power feed. The cross handles also provide a sensitive lever feed when small holes are being drilled.

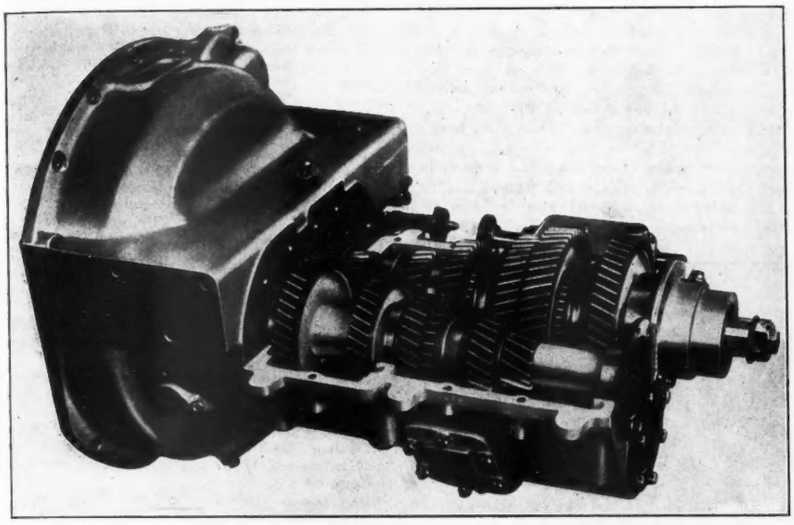
The gears driving the spindles are of hardened nickel-chrome steel and are carried on multi-splined shafts of high-tensile steel, mounted in ball bearings. The drilling heads are balanced independently by weights inside the column. The machine is designed to be portable, and is fitted with a lifting hook. The controllers provide forward, reverse and inching movements to the spindles and, of course, there is a button for instantaneous stopping. Built-in oil pumps maintain a supply of lubricant to the whole of the saddle mechanism, and visual indicators of the flow are placed in convenient positions. The floor space occupied by the machine, which weighs 8 tons, is 7 ft. 4 in. by 5 ft., and the overall height is 10 ft.

Low-Cost Housing Exhibition.—The Ministry of Works, Housing and Supply of the Government of India have organised an International Exhibition of Low-Cost Housing, which will be held on a site near the Old Fort, New Delhi, from Wednesday, January 20, to Friday, March 5, 1954. Further particulars may be obtained from the director, International Housing Exhibition, P Block, New Delhi, India.

Large Crushers for Nickel Ore.—Five crushers of exceptional size have been installed recently by the International Nickel Company of Canada, Limited, at their Creighton and Frood-Stobie Mines in northern Ontario as part of the company's underground-mining expansion programme. Each of these machines weighs 165 tons and will crush about 450 tons of ore an hour, reducing it to 8-in. lumps. The ore is dumped from haulage cars at the underground tipple and passes down a chute to the crusher, which has a swing jaw weighing 16½ tons. The speed of the ore feed to the crusher is regulated by seven chains with 110-lb. links and a total weight of 13 tons. The stations housing the crushers at the International Nickel Company's mines are located from 500 ft. to 5,000 ft. below the surface. Each station is lined with reinforced concrete and the back is supported by heavy steel beams.

GEARBOX FOR COMMERCIAL VEHICLES.

DAVID BROWN & SONS (HUDDERSFIELD) LTD., HUDDERSFIELD.



ANNUALS AND REFERENCE BOOKS.

The Airport Visitor.

Edited by SQUADRON LEADER N. J. FREEMAN and G. D. H. LINTON, Penman Enterprises Limited, 202, Cheam Common-road, Worcester Park, Surrey. [Price 2*s.* 3*d.* post free.]

As its title implies, this compact paper-covered illustrated volume is intended to serve as a guide for the general public to the activities at the national airports of the United Kingdom. Published with the approval of the Ministry of Civil Aviation, it is concerned mainly with those airports which are provided with public enclosures—London Airport, Northolt, Prestwick, Liverpool (Speke), Blackpool (Squires Gate), Birmingham (Elmdon) and Manchester (Ringway). Particulars of the facilities available at these airports are given, together with a list of other public and private airports in the United Kingdom. This is followed by an alphabetical guide to the various types of air liners that may be seen at British airports, giving brief details of their layout and accommodation, power plants, all-up weight, span, and cruising speeds. In addition to several contributed articles of general interest, short general descriptions of airport control and lighting systems are given, and a list of registration numbers of civil aircraft operating from airports in the United Kingdom is included. The booklet also contains a directory of British and foreign airlines, listing the types of aircraft and the routes operated by them. The *Airport Visitor* can be recommended as a useful and authentic pocket reference book for all who are interested in commercial aviation.

Gear Lubrication.

Wakefield-Dick Industrial Lubricants Division, C. C. Wakefield and Company, Limited, 46, Grosvenor-street, London, W.1. [Gratis to approved applicants.]

WHILE primarily designed as a guide to the selection of Wakefield oils for particular purposes, this little book is something more than a mere advertising brochure. It provides, in fact, a useful summary of the various forms of gearing and the methods of lubricating them, with indications of the problems likely to be encountered and the methods of overcoming them. Frequent reference is made to papers read before the leading professional institutions, in which the technique of gear design and lubrication has been discussed; and numerous examples are given, from modern engineering practice, of gearboxes, gear trains, etc., for motor-car, aircraft and other power plants and transmission systems, all of which are illustrated by reproductions of drawings supplied by leading manufacturers. The chapters on "Factors Influencing Gear Life and Performance" and "Gear Failure" should be of service to those who have to trace and cure troubles with gearing, as well as to the occasional designer who may not have the advantage of the experience which guides the expert.

Metal Industry Handbook and Directory, 1953.

Forty-second edition. The Louis Cassier Company, Limited, Dorset House, Stamford-street, London, S.E.1.

UNLIKE most reference books, this handbook is not on sale to the general public, but is available only to subscribers to *Metal Industry*, the cost being included in the annual subscription to that journal. It consists of four sections, of which the first, occupying considerably more than half of the book, deals with the general properties of metals and alloys and provides a concise but comprehensive survey of all the metals and compositions in general use, proprietary alloys, and British Standard, D.T.D. and Admiralty specifications for non-ferrous alloys. There follows a section containing miscellaneous data and tables, such as conversion factors, weights of sheets, rods, wire, etc., contents of crucibles, metal prices, and melting temperatures. Section III deals with the processes of electroplating, polishing and finishing; and Section IV is a directory, a useful feature of which is the information given about the numerous professional societies, research associations, etc., concerned with the use of metals in science and industry. The handbook is such an excellent publication that, we feel, the publishers might well consider the advisability of issuing it in cloth covers instead of paper, as at present.

The B.I.M.C.A.M. Handbook, 1953.

The British Industrial Measuring and Control Apparatus Manufacturers' Association, 21, Tothill-street, London, S.W.1. [Gratis.]

THE twin sciences of measurement and control, as applied to industrial processes, have made such immense progress in the past 20 years or so that it is not surprising to find, even among convinced believers in the principles, considerable uncertainty regarding the fields covered by particular makers of the instruments and apparatus appropriate to their needs. To such inquirers, this handbook should prove of considerable value, as it provides a compact and well-arranged key to the products of the 27 firms who constitute "Bimcam," with all the information necessary, regarding the firms themselves, to facilitate further inquiry. Rather more than half of the book is devoted to "Members' Announcements," and it is gratifying to note that these are not merely single-page proclamations of the too-familiar "ours is best" variety, but are really useful guides to the specific fields of instrument-making covered by the respective firms. The introductory section on "The Industry and Its Association" embodies some interesting historical information, and is illustrated with good examples of the many industrial applications of scientific measurement and process control.

CONSTANT-MESH FIVE-SPEED GEARBOX.

FOLLOWING the extensive road-testing of prototype models of the gearbox shown in the accompanying illustration by a number of the commercial-vehicle manufacturers, David Brown and Sons, (Huddersfield), Limited, Huddersfield, have begun production of this new constant-mesh five-speed gearbox. It is known as the David Brown 557 CM, and has been designed for commercial and passenger vehicles of 22 tons maximum weight. Whereas the previous model employed the crash-type of first, second and reverse gears, the new box has constant mesh in all gears. The top gear is a direct drive. The gearbox can be mounted behind the clutch housing of an engine or installed as an independent unit and can be supplied to suit either right-hand or left-hand driving positions. It has a large facing at the driven end for bolting to the bell housing of the clutch. When the box is mounted elsewhere the facing can be bolted on to a cross-bearer or bracket supported by the chassis; this arrangement, in conjunction with the locations at the rear, provides what is virtually a three-point mounting.

The gears are all of the single-helical type and are made from 3½ per cent. nickel-chromium steel and case-hardened. The teeth are shaved after cutting. The tooth forms have a 20-deg. pressure angle, with the profiles modified to obviate tip interference under heavy load. A centre bearing, incorporated in the intermediate wall of the aluminium case, provides an independent support for the final shaft. A roller-bearing carries the primary shaft and a location bearing takes the axial load from the gears. Three roller-bearings support the lay-shaft and the two outer bearings have lips to locate the shaft axially. The main shaft is carried on a roller bearing at the front end and on a deep-groove ball-bearing at the rear. Roller bushes each with two rows of large rollers, are fitted to each of the loose main-shaft gears.

An auxiliary drive is provided to accommodate a high-pressure brake pump which can be fitted to the rear of the gearbox, and the drive is arranged so that the pump can function at all times, including when the gears are in the neutral position. The approximate weight of the gearbox complete with the bell housing and the forward control, is 410 lb. For a vehicle of 15 tons capacity and 22 tons loaded weight, the maximum engine torque is 4,200 lb.-in., with a minimum axle ratio of 6·25 : 1. Standard gear ratios are 1 : 1 (5th), 1·565 : 1 (4th), 2·74 : 1 (3rd), 4·68 : 1 (2nd), and 7·92 : 1 (1st and reverse gears).

CONVERSION OF THE ORIENT LINER "ORONTES."—To cater for passengers who prefer one-class travel, the Orient Steam Navigation Co., Ltd., Bishopsgate, London, E.C.2, have announced that the 20,000-ton liner Orontes, now carrying first-class and tourist-class passengers, is to become a one-class vessel, for tourist-class passengers only, from August 29. The conversion will take place while the ship is in Sydney and will provide an increase of 250 in her passenger-carrying capacity. The Otranto, the Orient Line's other tourist-class vessel, was converted to a one-class liner in 1949.

INQUIRY INTO THE PROBLEMS OF OLD AGE.—Mr. R. A. Butler, Chancellor of the Exchequer, announced on July 27 that the committee he had set up to examine the economic and financial problems confronting old people, including difficulties respecting employment, would function under the chairmanship of Sir Thomas Phillips. Other members of the committee would be Professor A. K. Cairncross, Professor of Applied Economics at Glasgow University; Mr. F. A. A. Menzler, chief development and research officer, London Transport Executive; Dr. Janet Vaughan, Principal of Somerville College, Oxford; Mr. J. H. Gunlake; and Sir John Imrie. On the nomination of the Trades Union Congress and the British Employers' Confederation, Mr. Butler stated, the following would also be members of the committee: Mr. C. Bartlett, President of the Confederation of Health Services; Mr. A. McAndrews, a member of the T.U.C. General Council; Sir Cuthbert Clegg, chairman of the Cotton Spinners' and Manufacturers' Association; and Mr. F. J. C. Honey, joint secretary of the British Employers' Confederation.

NOTES ON NEW BOOKS.

Fifty Years of Economics.

By PROFESSOR H. O. MEREDITH. British Association for the Advancement of Science, Burlington House, London, W.1. [Price 7*s.* 6*d.*]

THIS survey is based on a paper read by the author at last year's Belfast meeting of the British Association, and raises the question whether economics is, as is sometimes claimed, a science. Professor Meredith quotes approvingly a dictum of Jevons, that "economics deals throughout with quantities; it must be a mathematical science in matter if not in language." Other writers on economics have been philosophers; and since people form the field as well as the materials of any experiments, it would seem reasonable that psychology should be able to afford some guidance, were it not for the fact that the use that is sometimes made of what is called psychology is apt to inspire distrust of those who claim to speak in its name. Those old enough to recall the state of the engineering industry in the days, half a lifetime ago, of uncontrolled competition, with no security of employment, no research, and little development, may be inclined to smile wryly at the enthusiasm for price competition, now apparently regarded as the one important consideration in a healthy economic condition. Those who fostered industrial co-operation laid the foundations on which has been built up a prosperous and energetic industry, fertile in invention, able to plan and to carry out vast undertakings. Professor Meredith points out that the views of economists are sought to a greater extent than ever before—not for the purpose of advising on the goal or the way thither, but for analysing situations, and estimating the probable results of different possible lines of action. He observes, rather sadly, that it is a pity that a man of his ability should so often find the subject of economics beyond his comprehension; and, remembering the direct conflict of opinion revealed in the Ridley Report, the conclusion seems to be that sound engineering knowledge and common sense are likely to be better guides.

Wells and Boreholes for Water Supply.

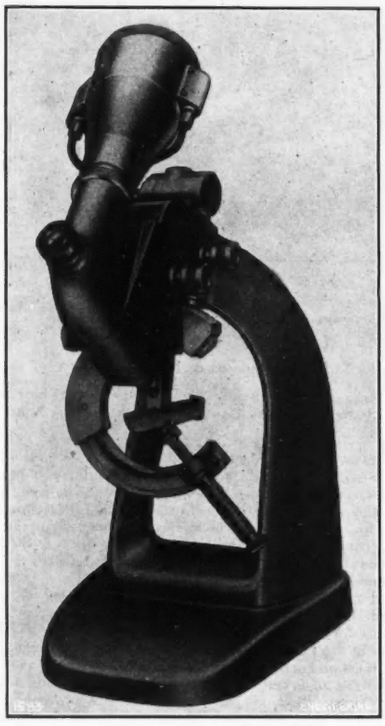
By J. E. DUMBLETON, M.I.C.E. Second edition. The Technical Press, Limited, Gloucester-road, Kingston Hill, Surrey. [Price 17*s.* 6*d.* net.]

THE first edition of this small book appeared as long ago as 1925. During the intervening period, the water consumption both of individuals and of industry has increased significantly and the indications are that the consumption is likely to continue to increase. In cities, the daily requirement is at present 50 gallons per person; in rural areas, the demand is smaller, but the requirements for agricultural use are increasing rapidly and, at the same time, the standard of purity now demanded is far higher than was considered necessary only a few years ago. That upland sources and large rivers are now possibly exploited to the full compels an interest in utilising underground supplies and the book has therefore been re-published to assist those concerned in the search for underground water. The author has revised the text to include notes of modern improvements in drilling, though he observes that such work continues to follow well-established practices. The chapters on the properties, analysis and purification of water have been re-written to bring them into line with recent developments. On water divining, the author cautiously observes that "increasing reliance is being placed on divining for the exact location of a site for boring" but, while remaining non-committal on this subject, he gives a short but informative list of material signs that should help searchers to recognise the presence of underground water and the conditions favourable to concealed springs.

URANIUM DEPOSITS IN ONTARIO.—A rich find of uranium-bearing material, identified as a finely-disseminated pitchblende, has been proved 100 miles east of Sault Ste. Marie, on the north shore of Lake Huron. With roads and railways already in the region, the ore is expected to be mined and despatched at a low cost.

MICROSCOPE FOR EDGES OF TURBINE BLADES.

A MICROSCOPE for checking, with great accuracy, the shapes of the leading and trailing edges of turbine blades against a master drawing has been developed by Messrs. Taylor, Taylor and Hobson, Limited, Stoughton-street, Leicester, and is illustrated herewith. It was demonstrated at the recent British Instrument Industries Exhibition at Olympia. The microscope can be used in full daylight, and can handle blades up to 2½ in. wide, of any desired length. Blades up to about 8 in. long are held against a V fitting by a spring plunger. Longer or very heavy blades may require to be held against the fitting by hand. Any part of the blade edge can be viewed, up to within about ⅛ in. from the root or shroud. The field of view at the blade



edge is 0·18 in. in diameter. The shape of the blade edge is magnified × 40, rendering errors of 0·001 in. from the master profile easily visible. The master drawing is prepared, 20 times size, on a card 3½ in. by 4½ in., which is inserted in a holder on the instrument. The card is seen through the eyepiece which has a magnification of × 2.

The microscope works on the light-slit principle. A narrow band of light is projected obliquely round the edge of the blade to outline the section, which is viewed obliquely through the microscope, the optical elements of which are arranged so that the obliquities cancel out. Thus, the image seen through the eyepiece is that of the normal cross-section of the blade. Vertical and horizontal adjusting screws permit the blade image to be quickly lined up with the drawing. The brightness of the drawing image can be adjusted relatively to that of the blade image, thus catering for both dark and bright blades. Eyepiece graticules are not required.

STABILISATION OF PRICES OF TINPLATE.—Mr. Duncan Sandys, Minister of Supply, has issued an Order for the stabilisation of tinplate prices. The Order will increase the price for tinplate by 1*s.* 1*d.* a basis box and for tin-coating extras by corresponding amounts. In consequence, however, of the price reduction resulting from the operation of the "automatic variation adjustment" for tin, the maximum permitted selling prices for tinplate will not be altered. The Order (entitled The Iron and Steel Prices No. 3 Order 1953, S.I. No. 1017) is obtainable from H.M. Stationery Office, price 2*d.*

BOOKS RECEIVED.

United States National Bureau of Standards. Circular No. 539. *Standard X-ray Diffraction Powder Patterns.* In two volumes. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 45 cents each volume.]

Mitteilungen aus dem Institut für Aerodynamik an der eidgenössischen technischen Hochschule in Zürich. No. 20. *The Secondary Flow in Curved Pipes.* By DR. RALPH W. DETRA. Verlag Leemann, Stockerstrasse 64, Zürich 39, Switzerland. [Price 15.60 Swiss francs.]

Careers in Chemical Engineering. The Institution of Chemical Engineers, 56, Victoria-street, London, S.W.1. [Price 2*s.*, post free.]

British Regional Geology, Northern England. By T. EASTWOOD. Third edition. H.M. Stationery Office, Kingsway, London, W.C.2 [Price 4*s.* net.]

The Behaviour of Aluminium Alloy Riveted Joints. By PROFESSOR A. J. FRANCIS. Research Report No. 15. Aluminium Development Association, 33, Grosvenor-street, London, W.1. [Price 7*s.* 6*d.*]

Small Transformers and Inductors. By K. A. MACFADYEN. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 37*s.* 6*d.* net.]

Pipefitters Handbook. By FORREST R. LINDSEY. The Industrial Press, 148, Lafayette-street, New York 13, U.S.A. [Price 6 dols.]

Atomic Transmutation: The Greatest Discovery Ever Made. From Memoirs of Professor Frederick Soddy, M.A., LL.D., F.R.S. By MURIEL HOWORTH. New World Publications, Abford House, Wilton-road, London, S.W.1. [Price 12*s.* 6*d.* in paper covers, 20*s.* in white-gold linen; library edition, in white-blue linen, 15*s.*]

Introduction to Hydraulics and Fluid Mechanics. By PROFESSOR JACOB O. JONES. Harper and Brothers, 49, East 33rd-street, New York 16, U.S.A. [Price 6 dols.]; and Hamish Hamilton, Limited, 90, Great Russell-street, London, W.C.1. [Price 48*s.*]

Report of the Radio Research Board with the Report of the Director of Radio Research for the Year 1952. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s.* net.]

References to Scientific Literature on Fire. Part V. 1951. By E. M. SHAKESHAFT and others. Fire Research Station, Boreham Wood, Hertfordshire.

United States National Bureau of Standards. Circular No. 537. *Table of Dielectric Constants and Electric Dipole Moments of Substances in the Gaseous State.* [Price 20 cents.] No. 541. *A Spectrophotometric Atlas of the* $^2\Sigma^+ - ^2$ II *Transition of OH.* [Price 20 cents.] The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.

C.A.B.M.A. Register of British Products and Canadian Distributors, 1953. Published for the Canadian Association of British Manufacturers and Agencies by Kelly's Directories, Limited, 186, Strand, London, W.C.2, and Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 2 guineas.]

Symposium on the Use of Radioisotopes in Soil Mechanics. March 5, 1952. American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. [Price 1.25 dols.]

Symposium on Direct Shear Testing of Soils. June 26, 1952. American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. [Price 2 dols.]

La Machine-Outil. Published under the direction of PROFESSOR A. R. MÉTRAL. Vol. I. *Généralités-Machines-Outils et Usinage.* [Price 4,400 francs.] Vol. IV. *Usinage par Outils en Translation.* [Price 4,600 francs.] Dunod, 92, Rue Bonaparte, Paris (6e).

The Airport Visitor, 1953. Published with the approval of the Ministry of Civil Aviation. Edited by SQUADRON LEADER N. J. FREEMAN and G. D. H. LINTON. Penman Enterprises, Limited, 202, Cheam Common-road, Worcester Park, Surrey. [Price 2*s.* 3*d.*, post free.]

Handbuch der Hartmetallwerkzeuge. By DR.-ING. W. DAWIHL and DR.-ING. E. DINGLINGER. Springer-Verlag, Reichpietschufer 20, Berlin, W.35. [Price 15.60 D.M.]

Electric Resistance Heating. British Electrical Development Association, 2, Savoy-hill, London, W.C.2. [Price 2*s.*, post free.]

Circuit Breaking. Researches by the British Electrical and Allied Industries Research Association. Edited by H. TRENCHAM. Butterworths Scientific Publications, 88, Kingsway, London, W.C.2. [Price 30*s.* net.]

Tool Engineers' Data Book. By GERHARD J. GRUEN. Reinhold Publishing Corporation, 330, West 42nd-street, New York 36, U.S.A. [Price 5.50 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 44*s.* net.]

Moteurs et Turbines à Combustion Interne. By PROFESSOR M. SEILIGER. Dunod, 92, Rue Bonaparte, Paris (6e). [Price 2,950 francs.]

Practical Jig- and Tool-Making. By ROBERT S. CONNELL. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, London, W.C.2. [Price 12*s.* 6*d.* net.]